NATURE

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" To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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Of Nature trusts the mind which builds for aye."—WORDSWORTH

THURSDAY, MAY 1, 1879

COUES'S "BIRDS OF THE COLORADO"

Birds of the Colorado Valley. By Elliott Coues. Part I. *Passeres to Laniidæ.* Bibliographical Appendix. United States Geological Survey of the Territories. Miscellaneous Publications—No. 11. 8vo, pp. 807. (Washington, 1878.)

WHAT is commonly called a "popular" zoological work is nearly always one that is bad. The knowledge possessed by the writers of such books is seldom greater than that of the public for whose benefit the books are ostensibly published, and is far behind that of a moderately well-informed student of the particular branch concerned. We shall name no names, but our readers will doubtless be able to supply several instances n support of this assertion without inconveniently taxing heir memories. Within a very short space of time they iave seen the works of two English naturalists, whose vritings have long attained a classical position, subjected o such treatment at the hands of "popular" editors as vould "make the angels weep," if those celestial beings ›e actuated by human affections, while the number of ›ooks independently put forth by "popular" sciolists is ›ast counting. These books have their day—and someimes it unfortunately is a long day. Granting that they o some good by administering to or fostering the taste or natural history already so widely spread, the evil they erpetrate is far greater. This evil lies first in their nstilling for the most part erroneous ideas into the nnocent pupil, and secondly in their occupying and ncumbering the ground to the exclusion of better books, hich drop still-born from the press. The struggle for xistence is admittedly slow in operation, and though we oubt not which way the triumph will eventually be, the nd is far off, and ere it arrive dire mischief is done. he falsest notions are promulgated, the feeblest arguents are maintained, and the learner at last discovers his sorrow that, instead of proceeding joyously on his ›urse, he has to unlearn what he has acquired. Someing may be said in favour of the mental discipline thus undergone, but on the other hand must be weighed the waste of time that attends the process, and the spirit of the age is against any discipline that is in the least doubtful of effect. As an epithet to a work on zoology, "popular" in nine cases out of ten really means debasing.

It is therefore with great pleasure that we can declare the volume before us—"The Birds of the Colorado Valley"—to be a popular book, not in the common sense but in the uncommon, highest and best meaning of the phrase. Dr. Coues has long since attained a scientific reputation that cannot be gainsaid. His numerous works are as well known and as highly esteemed on our side of the Atlantic as on his own, and one quality which is conspicuous in all of them is their thoroughness. When Dr. Coues writes a sentence he is in earnest, and there is no mistaking what he says. Whether the subject be the laboured description of an animal whose fur or plumage is mottled and diversified by the most delicate combination of tints—many a rodent, an owl, or goatsucker for example; the unravelling of an abstruse question of complicated synonymy; an account of the economy of a beast or bird to be given from his own wide experience or compiled from the observation of others—this quality is manifest. He has of course his faults. Some of them he has not been slow to acknowledge, but there is seldom a fault in his works that can be fairly called a blunder, and even such blunders were they twice as great and twice as numerous we could readily pardon, for there runs through all his writings, showing itself at times even in the driest spots, a humorous vein that can scarcely fail to excite a sympathetic flow even from the sternest of scientific breasts. In this volume Dr. Coues gives freer play to his lighter mood than, we think, in any of his former works, and at times (though he can be as serious when he pleases as the strictest man of science would wish) there is a boyish elasticity in his style which is exceedingly pleasant. He is always a readable author, whereby we mean that apart from the value of the information we derive from his statements, he clothes them in agreeable language, which far too many of his zoological brethren neglect to do. Nor is there any attempt at fine writing, which of course is a great mistake—*the* mistake in fact

into which "popular" naturalists fall. Here is a passage which we extract, since it relates to a species now considered to be common to Europe and North America—the Tree-Creeper (*Certhia familiaris*)—and its accuracy will be recognised by all who have watched the bird in this country:—

"The leading trait of the Brown Creeper is its extraordinary industry—the 'incomparable assiduity,' as it has been well styled, with which it works for a living. Like all good workers, the creeper makes no fuss about it, but just sticks to it. So quietly, yet with such celerity, does it go about its business that it scarcely seems to be at work, but rather to be rambling in an aimless way about the trunks of trees, or at most only caring to see how fast it can scramble up to the top. During all this time, however, the bird is on the alert in the search for insects, which it extracts from their lurking-places with such dexterity that its progress is scarcely arrested for a moment; and the number of these minute creatures yearly destroyed is simply incalculable. The creeper is strongly attached to the trunks of large trees, being seldom seen foraging on even the larger branches; and it has a great fancy for travelling upward. These two traits combined result in its marked habit of beginning its curious search for insects near the bottom of a tree, and ascending with jerks in a straight or spiral line to the top. Then, if it likes the tree, and thinks it a good place to stay a while longer in, the bird launches itself into the air, and drops down on wing, to begin another ascent, in preference to scrambling down again, as a woodpecker or nuthatch would do. The easy, gliding motion with which it climbs has deceived one writer into stating that the creeper does not hop along like a woodpecker; but, in fact, the movement is exactly the same in both cases. One of the English writers (Barrington, Zool. 2nd ser. p. 3998) describes, however, something peculiar in the position of the feet during the act of climbing:—These, he says, are not held parallel with each other, and near together, under the belly, but widely straddled, and thrown so far forward as to form with the end of the tail a surprisingly broad-based isosceles triangle. So nimble is the bird, and such a sly way has it of eluding observation by turning in the opposite direction to that in which a person moves to look after it, thus continually interposing the trunk of the tree in the line of vision, that it is no wonder the way it holds its feet long remained unascertained. Many things conspire to screen the queer little bird from any but the most patient and closest scrutiny during its ordinary vocations; and so nearly do its colours correspond with the tints of the bark that it is likely to be overlooked altogether. But its habits are so methodical and undeviating that when one has learned them there is no difficulty. If we see a creeper alight at the base of a tree on the side away from us, we have only to stand still, and keep a sharp look-out for it higher up; in a few moments, its spiral twisting will bring it round to our side; the chief point is to look high enough up, for it is surprising how rapidly the bird ascends. It generally makes the whole journey before dropping on wing to the base of the tree again, or making off to another; sometimes, however, the tree seems to be not to its liking, when, as if actuated by a sudden impulse, it abandons an unprofitable search, and flies to a more promising feeding ground."

This is a very fair sample of the author's style in treating of birds' habits, but many extracts would be needed to show the enormous pains he has taken with the more scientific part of the book. The array of references prefixed to the account of each species is almost appalling, but when we come to look into them we find these citations are not printed merely for the sake of giving an exhaustive list, but that there is a sufficient purpose for the insertion of almost each of them. In like manner we can praise the care bestowed on the technical characters of the several species, so far as we have been able to test them, for in diagnosis, that touchstone of a descriptive biologist, Dr. Coues especially shines, as indeed one expect might from the author of the "Key to North American Birds."

There is, however, one thing in this volume that we must say has excited our wonder, and must, we suspect, have deeply disturbed the minds of more than one naturalist who has read it. Dr. Coues, fully conscious of the risk he is running, cannot bring himself to reject the notion of Swallows and other birds plunging into the water in autumn and passing the winter in deep slumber! He admits that "it is as much as a virtuous ornithologist's name is worth to whisper hibernation, torpidity, and mud!"; but he adds further on, "It is not permitted to us, in the present aspect of the case, to rule out the evidence" in favour of what, for our own part, we must unhesitatingly call an exploded fable. It is certainly as much as a virtuous reviewer can do to treat this matter calmly. Yet we hold ourselves a better judge of evidence than Dr. Coues, and in spite of this singular aberration we draw our conclusion from the rest of his work that his reputation for sanity need not be thereby impugned. But he certainly overstates his case when he says that "the testimony, so far from ceasing with the irresponsible infancy of science, is reiterated to-day with the full voice of science, in terms that have not been successfully refuted." Now what is a successful refutation to one man, we all know, is not necessarily so to another. Are there not virtuous gentlemen who still insist on having proved the flatness of the earth, the squaring of the circle, and various geometrical impossibilities, and does not their very existence show that their testimony has not been "successfully refuted"? Nothing short of a miracle will convince some people, and we say this in view of both believers and unbelievers in the torpidity of birds. From whom is "the full voice of science" to be heard if not from scientific men, and where is the scientific man of to-day (Dr. Coues himself excepted) whose testimony reiterates that of Achard, Dexter, Pollock, Kalm, Forster, and the rest of those named in our author's excellent bibliography of the subject? We may have persons of intelligence and veracity, of respectability and honour, but we find not of late years one scientific man who can vouch for any statement of the kind on his own authority. It would be idle, however, to pursue the subject further; we should like to know, nevertheless, whether Dr. Coues refuses to reject the testimony as to the existence of Were-wolves, which seems to be on a par with, or even stronger than that in regard to, the torpidity of birds, and we shall only add that we think he is indeed "greatly mistaken" in his view that the Chimney-Swift (*Chætura pelagica*) "is not recorded as occurring anywhere beyond the United States in winter." If he will refer to a certain "Nomenclator Avium Neotropicalium," published not long since, he will find this species entered as occurring in Mexico, and we think we "could give reasons for the supposition" that it winters regularly in that country and others lying further to the south, instead of "hibernating in hollow trees" in the United States, so that what-

ever our author builds upon his basis would seem to have an unstable foundation.

We have just mentioned the excellent bibliography of the swallow-question given by Dr. Coues, but this is by no means the only one contained in his work. By way of appendix we have a "List of Faunal Publications relating to North American Ornithology," with a most useful double index (of authors and localities) thereto, the whole extending over more than 200 pages. The like of this we know not elsewhere, and we cannot sufficiently thank him for it. It makes us forget and forgive the single *escapade* which we so much regret having had to notice. One remarkable merit it possesses is that except in specified cases—and these, it is easy to see, are very few in number—no title has been taken at second-hand. More than this, we are told that the present batch of titles is but an instalment of a Universal Bibliography of Ornithology which the author has in hand, and towards which he has already collected about 18,000 titles! We are sure our readers will agree with us in hoping that Dr. Coues will be able to complete his laborious task, as well as in considering that its completion will redound to the already great credit of the department over which Dr. Hayden presides, and also to the medical staff of the United States army, which numbers Dr. Coues among its members.

BRITISH BURMA

British Burma and its People. By Capt. C. J. F. S. Forbes, F.R.G.S., M.R.A.S., &c. (London: John Murray, 1878.)

THIS book is offered as the result of thirteen years' experience derived from close intercourse, both officially and privately, with the people of Burma during that period. Such works are frequently contributed by the pro-consuls of the British empire, and afford, apart from their scientific value, good material to judge of the men and methods of our colonial government. Their merits are naturally unequal. The volumes of Raffles and Tennent, become classical, supply the corner-stones of future compilations, and are the exciting causes of a more ephemeral literature. It is, however, seldom that we see combined with the administrative capacities of our governors and commissioners a thorough knowledge of the ethnology, biology, and physical characteristics of the regions over which they preside. When such a man appears, and further possesses the quality of observation, his work marks an epoch, and English rule receives a new significance. It is in no adverse spirit that we say thus early that Capt. Forbes' work will not rank in this category, and we desire rather to commend it for what it does possess than to criticise it for the information which it does not supply.

Omitting the long narrow strip of mountainous country and sea-coast which forms the Tenasserim province below Maulmain, British Burma may, roughly speaking, be said to consist of three broad mountain ranges, having outside them on the west the sea-board province of Arracan, embracing between them the two great valleys of the Irrawaddy and the Sittoung, which forms, south of Rangoon, one vast plain, the centre range of the three mountain chains being shorter than are the other two. Its physical geography is interesting and peculiar, and in its pluvial character most characteristic and remarkable. The wet season lasts from about May to October, and during these five months of almost constant rain the average rainfall amounts to 184 inches at Maulmain,—in one exceptional year to 228 inches. During this period the great Irrawaddy rises 40 feet above its summer level and floods the surrounding lowlands, whilst its main current travels with a velocity of five miles an hour. Many proposals have been made to found sanatoriums for Europeans on the high mountain ranges of Burma, but however pleasant in summer, they would, says Capt. Forbes, "have to be abandoned to the jungle beasts and the elements during the rains, for not even natives could remain to take care of the buildings; and so incredibly rapid and luxurious is vegetation there, that the very next year a forest would have to be cleared away to find the houses again." December, January, and February are the cold months, whilst the hot weather lasts from February till the rains commence again. The climate, however, is excellent; the registration returns show that the deaths of children under five years of age are in the proportion of 27·85 of the total death rate; the percentage of children under twelve years of age is 35·8 of the whole population.

The chapter on the physical geography of the region is evidently compiled from careful authorities. The author appears to have undertaken no original investigations, nor to have added any original information on the subject; the biological effects of these annual inundations, in such a region teeming with animal life, excite the profoundest interest, but await the chronicle of a qualified observer. The principal part of the volume is occupied with an account of the people of British Burma, which the sociologist may find a storehouse of useful facts, and which must prove of the greatest value as an introduction to the ethnology of the region to all such as are approaching that subject. The statistical tables of the Census Report for British Burma, 1872, "give eighteen divisions of the indigenous races of so-called Mongolian origin." According to Capt. Forbes four great races occupy the Burman peninsula—the Mōn, the Karen, the Burman, and the Taï, or Shan, of which the Mōns form the majority of the inhabitants of British Burma. As regards the author's endeavour to give "a probable account of the route and order by which they arrived in their present localities," we must refer the reader to his arguments, and, without expressing an opinion thereon, will merely remark that even in science, when the rigour of induction is at all relaxed, a sentence written by Mr. Leslie Stephen is very applicable—"one clever man's guess is as good as another, whatever the period at which he lived." The chapters devoted to "social life and manners," &c., are very valuable to the comparative ethnologist. Some of these facts have been related before, but collected thus in a compendious form, and enriched with the results of a long official experience, they form material to supply links in that chain of generalisations which during the last few years in the hands of Tylor and Lubbock have created a new branch of anthropology.

Among the hill tribes the Karens are now divided between "those who have permanently settled in the plains and betaken themselves to a regular system of agriculture

and those who still remain in all their primitive freedom of the hills." This freedom, however, consists of a long and bitter struggle to raise their scanty crops on the hardly-wrought clearances of the virgin forest. Among the other enemies to their agricultural pursuits, Capt. Forbes mentions the visitations of vast hordes of "hill rats," which at long intervals of forty or fifty years settle on a tract of country for two or three years in succession, "till, like a swarm of locusts, they have reduced it to a desert." When on the move, in vast swarms, they cross the streams in shoals, so that the water is black with them, and from 1870 to 1874 they so devastated the hill country east of the Sittoung river that government was compelled to expend some 10,000*l.* in relieving the local Karen tribes.

The chapters upon Burman Buddhism must not pass without notice. Buddhism is not a subject quite suitable to the columns of NATURE, but there is exhibited in the short treatment of it such an intelligent appreciation of a vast system of philosophy, unaccompanied by narrow prejudice or preconceived ideas, as, if not perfect, proves the author to be capable of conducting investigations on thoroughly scientific principles.

W. L. D.

OUR BOOK SHELF

From Kulja, across the Tian Shan, to Lob-Nor. By Col. N. Prejevalsky. Translated by E. Delmar Morgan. With Introduction by Sir J. Douglas Forsyth, C.B. (London: Sampson Low and Co., 1879.)

COL. PREJEVALSKY has already proved himself one of the most scientific and determined of modern explorers, and has probably done more than any single man for an accurate knowledge of Central Asia. We have noticed in these pages his valuable work on his journey in Mongolia and Western China, and this narrative, short as it is, maintains the reputation he has already gained. The journey here described was made in 1876-7, and has been the means of clearing up several obscurities in the hydrography of the region visited. We have already, shortly after Prejevalsky's return, given the main results of the journey, from Kulja, south-east across the Tian Shan Mountains, by the Yulduz River, to the Tarim, and along that river to its termination in Lake Lob-nor, at the northern foot of the Altyn-tagh Range, on the 90th deg. of E. long., and just south of the 40th parallel N. Baron von Richthofen has endeavoured to prove that the present Lob-nor is not the Lob-nor of the old geographers, which he maintains was farther north. But to this Prejevalsky has an answer that it seems to us difficult to refute, notwithstanding that Richthofen probably knows more about the history of Central Asian geography than any one living. However the case may stand with regard to this, there can be no doubt about the value of Prejevalsky's observations on the present Lob-nor, which he states is fresh, shallow, almost overgrown with tall reeds, in the midst of which its strange mongrel inhabitants live, and of which they build their houses. The Altyn-tagh Mountains Richthofen considers the most surprising discovery of the Russian traveller, for it was generally supposed that there was an extensive tract of low country continuing through several degrees of latitude to the south of the lake. Prejevalsky's observations on the fauna of the Tarim and Lob-nor will be appreciated by zoologists, as will also his account of the wild camel. He has a special interest in ornithology, and above all in that department relating to the migrations of birds; and the part of his narrative which describes what he observed on this point during his stay at Lob-nor is one of exceptional value, and will, no doubt, be read with interest and profit by those who take an interest in the subject of migration. Mr. Delmar Morgan, who has made an excellent translation, has added to the brief narrative chapters on Lake Balkash, Lake Ala-Kul, and the Starovertsi, which, though somewhat irrelevant, are acceptable as being of real value. An excellent large map accompanies the volume, besides a smaller one, to illustrate the controversy between Prejevalsky and Richthofen.

A Manual of Practical Chemistry: The Analysis of Foods and the Detection of Poisons. By Alexander Wynter Blyth, M.R.C.S., F.C.S., &c. (London: Charles Griffin and Co., 1879.)

THIS work of 468 pages consists of two divisions, the first treating of the analysis of the principal articles of diet in daily use, the second of the detection and estimation of certain organic and inorganic poisons. The matter pertaining to the first division is further divided into seven parts, in which the different articles of diet are considered in their proper groups. These chapters are well and pleasantly written, bringing the information as much as possible up to date, and introducing where necessary modern methods of analysis. This may be seen in the chapter on sugars, where a full description of the optical method for the estimation of these bodies by the polariscope is given, with an accompanying diagram of the various parts, lenses, &c., of Soleil's saccharimeter. The remaining portions of the first division contain the matter concerning bread and flour; milk, butter, tea, coffee, cocoa, &c.; the chapter on tea and coffee containing a large number of analyses which no doubt will prove of great use. A considerable part of the book is devoted to the examination of alcohols, wines, and beers, in which instructions are laid down for the examination of such substances. In connection with this part the author gives a reprint of the tables introduced by M. A. Gautier for the systematic detection of colouring matters likely to be met with in wines, and gives an abstract of Gautier's paper containing the necessary instructions for the preparation of the sample, &c., to be examined.

The second division of the book contains the detection and estimation of the different poisons, the consideration of the organic preceding that of the inorganic. Although the information conveyed by the author is exact and well arranged with regard to the individual tests for each separate poison, it is to be regretted that he has not thought it necessary to develop more fully his remarks on a systematic course to be employed in the separation of the different poisons from each other. In many cases where doubtful evidence of poisoning exists a most exhaustive analysis is required, and we fear the general instructions laid down in the book for this purpose, or "method of procedure in analysis," as the author terms it, are somewhat insufficient.

The organic poisons and the detection of phosphorus are first taken into account in two divisions, first, those detected mainly by methods of distillation, and second, those separated for the most part by alcoholic solvents. The consideration of mineral poisons is placed last in the book, and contains the usual received tests for these substances, with in some cases a description of the body. With regard to this latter part we do not see why in a book published so recently as 1879 there are no remarks on the detection or separation of tin as a poison since it has been shown in letters to some of the journals that this metal may contaminate articles of food, more especially tinned fruits.

The work is clearly printed, but some of the diagrams are somewhat crudely cut, and if refinement in the arrangement of apparatus is intended in the illustrations, hardly carry out the intention; thus in Fig. 15 it is diffi-

cult to see from the drawing what is meant in the arrangement figured between the washing bottle and the French drying tube. There are some traces also of careless printing, which it would be well to rectify in future editions, as in the equation of the action of arseniuretted hydrogen on silver nitrate on p. 372. The title of the book is also somewhat presumptuous; it is styled "A Manual of Practical Chemistry:" the two last words being in large type; a colon is here introduced and then follows the exact title of the book in smaller type, "The Analysis of Foods and the Detection of Poisons." The work cannot be fairly described as a Manual of Practical Chemistry, and the title should therefore have been restricted to the matter actually contained in the book.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

On the Spectrum of Brorsen's Comet

WITH reference to Prof C. A. Young's Note on the Spectrum of Brorsen's Comet, in NATURE, vol. xix. p. 559, it may be of interest to mention that observations made at the Royal Observatory, Greenwich, confirm his conclusion as to the coincidence of the brightest band in the comet spectrum with the green band of carbon.

We were not able to examine the comet's spectrum till April 17, as the Great Equatoreal was in the workmen's hands till that date for alterations required to allow of the more convenient use of the spectroscope. On that evening, and again on April 19, the comet's spectrum was repeatedly compared by Mr. Maunder and myself, with the spectrum of alcohol taken in a vacuum tube. The less refrangible edge of the brightest comet-band coincided as exactly as could be determined with the corresponding edge of the green carbon-band at 5,200, but the comet-band was very much wider, extending two-thirds of the way towards F (*i.e.*, about 200 tenth-metres), and covering the carbon-band at 5,200 (about 30 tenth-metres broad) and the two following fainter bands at 5,100 and 5,020. The comparisons were made on April 17 by the help of an occulting bar, and on April 19 with Hilger's bright-line micrometer, illuminated by red light. With the latter, readings for the comet- and carbon-bands respectively, agreed within half a tenth-metre. The half prism spectroscope with a dispersion of 10° from A to H (equivalent to two prisms of 60°) was used on the 13-inch equatoreal. From spectroscopic observations of the carbon compound, printed in the volume of Greenwich Observations, 1875, it appears that the bands in the spectrum of alcohol are identical with those in the spectra of olefiant gas, and of carbon oxide and dioxide.

A second band was seen in the orange of the comet's spectrum approximately coincident with the carbon band at about 5,600. This band was of about one-fourth the brightness of the principal band.

The results on April 17 were obtained without a knowledge of Prof. Young's work, and thus afford an independent confirmation of his conclusion. W. H. M. CHRISTIE

Royal Observatory, Greenwich, April 21

Blue Flame from Common Salt

I AM perfectly aware that, as Dr. Gladstone points out in your last issue, I have not *proved* HCl to be the origin of the blue flame, but I will give some of my reasons for *thinking* so.

In the first place I conclude every one will admit that chlorine in some form must be present, since only chlorides produce the flame. At one time I thought it was due to dissociated or atomic chlorine; that view, however, I discarded in favour of the hydrochloric acid theory.

When AmCl is heated, dissociation occurs, as is well known, NH_3 and HCl being formed; the HCl then plays its part in producing the blue flame. If calomel be used, it is natural to imagine that the mercury and chlorine are separated, and if the colour is due to HCl, the addition of hydrogen will be necessary before the flame is produced. As a matter of fact I have found that no coloration occurs if the calomel is heated in what I may perhaps be allowed to call the *solid* part of the Bunsen flame, *i.e.* where complete combustion takes place, but it is necessary to allow some of the unburnt gas to mingle with its vapour. In practice I adjust the wire gauze over the burner so that a black spot is seen surrounded by a red hot ring, a little calomel placed on the dark spot volatilises and colours the gas that is burning above the gauze; if the gauze is raised so that the dark spot vanishes and all is red hot, the salt volatilises without any coloration ensuing.

Although I have not been able to see any violet bands when a spark has been taken in HCl, I do not consider that it negatives my theory, since there is a considerable difference between an electric spark and a Bunsen flame, and I now have reason to think that under the influence of the spark the HCl is split up into its components, which will fully account for the absence of violet bands. I have likewise failed to get them from a spark in AmCl.

A drop of liquid HCl, introduced into a Bunsen flame by the aid of a platinum wire, gives a flash of blue colour, and a lighted taper immersed in a bottle of HCl gas has its flame surrounded by a blue mantle just before it goes out. The colour, to the eye, is identical in both cases to that produced by the volatilisation of a chloride, the peculiar violet tinge showing that it must contain rays of high refrangibility.

Lastly, if a stream of HCl gas be slowly passed into a large Bunsen flame, the colour is produced most vividly, the spectrum showing all the characteristic lines or bands. Here we have the HCl under the same conditions as the chloride and with a similar result.

Dr. Gladstone appears not to have obtained the flame by this method, since he says: "Hydrochloric acid passed into a flame never gives the violet light."

This may probably be explained by the fact that if the HCl be passed too rapidly the violet coloration gives place to green, similar to that produced by chlorine alone if the stream of gas be allowed to slacken, the violet is reproduced, and this may be repeated indefinitely. A. PERCY SMITH

Temple Observatory, Rugby, April 26

Did Flowers Exist during the Carboniferous Epoch?

ACCORDING to the position Mr. Wallace has taken in the discussion as to the order of insects to which *Breyeria borinensis* presumably belongs, everything depends upon the existence or non-existence of transverse reticulation. I re-assert that a regular and thoroughly well-marked transverse reticulation exists over all the wing.

If Mr. Wallace prefers to believe in the evidence afforded by a photograph in preference to my statement based upon actual examination, and to M. de Borre's words in his description ("Entre toutes ces nervures s'étend un réseau extrêmement complet de très-fines nervules allant transversalement d'une grosse nervure à l'autre"), it is evident that anything I could say would not alter his opinion.

Further, I utterly fail to comprehend by what process of reasoning he arrives at the conclusion that the photograph "is so beautifully sharp that it brings out the minutest details," when confessedly he has not compared that photograph with the original.

That the main nervures may be compared with some forms in Lepidoptera and found to agree to a certain extent is very possible; it would be singular if it were otherwise, considering the extreme variation in the neuration of Lepidoptera, and the practical certainty that the system of neuration in all orders of insects can be homologised. The presence of dense *transverse* reticulation in a lepidopterous insect would decidedly be an anomaly; but its absence would not prove that any particular fossil *did not* belong to the Ephemeridæ, for in some recent genera of the latter, such as Oligoneuria, Lachlania, &c., the transverse reticulation is so far absent as to be reduced to a few nervules that might be counted on the fingers of one hand.

Supposing, for the sake of argument, that my assertion may be based upon false premises (and no one is infallible), *Breyeria* would probably be relegated to that heterogeneous assemblage of extinct forms of insects possessing densely reticulate wings, to

accommodate which the order Palæodictyoptera has been formed. It is not for me to here enter into an examination of the materials included in this so-called order. It will suffice to say that not one of them could be suspected of being lepidopterous.

The point at issue is, did anthophilous insects (and therefore flowers also) exist during the carboniferous epoch? According to my views we are without evidence of their existence.

I decline any further discussion on this subject until Mr. Wallace has examined the fossil, or has obtained evidence of its peculiarities from some one in whose judgment he has more confidence than he apparently has in mine.

Lewisham, April 25 R. McLachlan

Captain Cook's Accuracy

In Nature, vol. xix. p. 408, there is an article entitled "Captain Cook's Accuracy," which I think reflects unjustly upon the late Admiral Wilkes, U.S.N. As a specimen of Wilkes's inaccuracy the writer of the article cites first the discrepancy in the position of Turtle Island, the south-easternmost of the Fiji group, Cook and Wilkes differing more than 30′ of longitude. The narrative of the U.S. Exploring Expedition was written on board ship during the progress of the work, and was placed by Wilkes in the hands of the printer immediately upon his return, in order that the general results might be known without delay. The astronomical positions were given as they were recorded at the time, and were not corrected for final chronometric errors and rates, which were carefully ascertained while the charts were being prepared for publication. A comparison of the narrative with the atlas, published subsequently, will exhibit differences of longitude almost throughout.

On the general chart of the Pacific, sheet III., which is on a very small scale, so that a slight inaccuracy of the draughtsman or engraver will cause a difference of several minutes, Turtle Island will be found to be in about 178° 22′ W. long., but the special plan of the island (vol. 2, p. 94, of the Atlas) places it in lat. 19° 47′ S., and long. 178° 16′ 18″ W., while Capt. Denham, R.N., in 1856, places it in 19° 49′ 11″ S., and 178° 14′ 42″ W., where it is at present shown on the British Admiralty Charts. The difference of latitude is about 1′ 45″; that of longitude, 1′ 36″; differences which might readily be accounted for by different points of observation having been used. The difference in the outline is not very material.

As Cook placed the Island in 178° W., he was fifteen minutes in error; while Wilkes differs from the latest surveys about a minute and a half. Capt. Worth, of H.M.S. *Calypso*, in 1848, placed the island in 178° 8′ W., differing seven miles from the subsequent survey by Capt. Denham, the position by the latter being now borne on the British Admiralty chart, yet the former authority is quoted to prove the inaccuracy of Wilkes's work.

Findlay, judging from what he says upon this subject, consulted Wilkes's book, instead of his chart, which was published subsequently. The second example of Wilkes's inaccuracy, cited by the writer, is that he found from a position which he occupied at Savaii, a trend of coast differing from that as shown by Wilkes's chart, but it is a question whether he was not mistaken in the identity of the point occupied by him. The waters of the Samoan group are, so far as we know, navigated safely and almost exclusively with Wilkes's charts.

The third and last example is concerning Quiros Island (Swain's Island). The facts in this case are that the boats of the exploring expedition did *not* effect a landing on the island at all; efforts were made to do so, but were unavailing on account of the surf, so that it is quite impossible that they could report the existence of a lagoon hid from their view by a wooded strip of land even if only a quarter of a mile in width.

In criticising the work of such explorers as Cook, Vancouver, and Wilkes, it should be borne in mind that the expeditions which they commanded were for exploring rather than surveying purposes, and it is rather a matter of surprise that they should have come so near the truth when we consider the crude materials with which they had to work. S. R. Franklin

Hydrographic Office, U.S. Navy, Washington, D.C., April 11 — Captain U.S.N. and Hydrographer

Sense of Force and Sense of Temperature

"J. T. B.'s" "discovery" of the distinction between muscular sensations—or, as he styles them, the "sense of force," whatever that may mean—and the sensation of temperature, has been long anticipated by Alexander Bain in his work on "The Senses and the Intellect."

Again, your correspondent's illustrations of the distinction he draws between absolute and relative muscular sensations and sensations of temperature are wholly illusory. How can it be said that a letter-sorter enjoys and improves absolute sensations of weight? Surely his sensations enable him to determine not "absolute weight" (whatever that may be), but the weights of particular letters relative to certain standards, according to which relation the postage is charged. These sensations enable him to say that certain letters are over, and others under, an ounce in weight, and thus they are in fact relative, not absolute, as "J. T. B." seems to suppose.

The same remarks apply to "J. T. B.'s" assertion that "the sense of temperature may also be rendered absolute to a certain extent," and to his illustration of the plumber who judges whether the heat of the soldering-bolt is adequate for his purpose. Here again the sensations are, in truth, purely relative, any inference drawn from them being based upon a comparison of present and previous sensations and present and previous experience of their results. A. K. R.

Mark Lane, April 23

Mr. Preston on General Temperature-Equilibrium

My attention has been arrested by Mr. S. Tolver Preston's paper on general temperature-equilibrium in Nature, vol. xix. p. 460, and by a letter from him in a later number (p. 555), pointing out a trifling literary ambiguity in it. As this implies that the paper is otherwise correct, you will perhaps allow me to protest, and to state that it is full of confusion of reasoning and of unsoundness.

I do not know how many sins against dynamics could be discovered by careful examination, but at least two pervade it throughout, viz. (1), the assumption that the simple relationship which exists between the movements and the temperatures of molecules of matter exists also between the movements and the temperatures of masses of matter; (2) the assumption that gaseous molecules (simple or compound) whose bond is chemical affinity differ mechanically from masses of matter (stellar or otherwise) in size and weight only, whereas they really differ in a multitude of other ways, and notably in elasticity; and from this difference alone it would be easy to show that the analogy in the paper is fanciful, and its reasonings and conclusions invalid, but I respect your space.

In conclusion I would say that I am not writing against the hypothesis of temperature-equilibrium itself. It may or may not be true. All I assert is, that this paper gives no real information about it. Wm. Muir

133, Upper Thames Street, E.C., April 26

The Migration of Birds

It was becau e Prof. Newton mentioned such distances as six, seven, and ten miles (*vide* Nature, vol. xix. p. 434), in connection with the flight of migratory birds, that I brought forward the matter of temperature, and the latter still appears to me to have as much bearing on the question, as has the density of the atmosphere.

The intense frost on Christmas eve, 1861, was said to have killed a large number of thrushes, blackbirds, &c., in Scotland. Near Edinburgh, where the thermometer registered about $-4°$ F. during the night, many dead birds were found. These deaths resulted from cold, not from starvation, for the weather was open until within a few days of Christmas day. Now, if a frost of this severity has such an effect on bird-life, surely it must be conceded that temperatures from $-25°$ to $-100°$ F.—those that would reign between six and ten miles' elevation, with surface temperature of $+80°$ F.—would slay the hardiest migrant.

There is a great difference between the elevation required to view a distant sea horizon, and an equally distant mountain-top. For instance, to obtain a sea-horizon of 300 miles, you must mount nearly twelve miles; but from an altitude of four miles, the summit of a mountain 20,000 feet high (less than 4 miles) would be visible, though its base lay 300 miles off. Similarly, if an elevation of 5,000 feet only be granted to the haze that constitutes the loom of land, birds flying two miles high will have a circle of vision, for the land indication, of over 200 miles radius. Under such circumstances, if the journey is 1,000 miles in length, a deviation of some 12° on either side of the true direction of flight

can be made by migrating birds, without leading them out of view of their destination. With shorter journeys it is evident the error of flight may be largely increased without endangering the safety of the migrants.

Migratory birds that are strictly nocturnal cannot cross any very great expanse of barren ocean, hence, unless their error of flight is large, and the land they wing their way to small, there is not much fear of their losing themselves. Moreover, if they do go wrong, dawn must assuredly bring back their powers of vision.

E. H. PRINGLE

Beckenham, April 27

An Observatory of Newton's?

THERE is a tradition associated with a domed building, now covered with ivy, situate on Stamford Hill, that it was once employed as an observatory by Sir Isaac Newton. Can any of your readers give any information upon the subject? Immediately beneath the revolving dome there is a well-shaped excavation (now partially filled with water) in which is an extinguisher-shaped stand, supposed to be of iron; this may have formed part of the base of a telescope, but no information upon the subject can be obtained from the local inhabitants.

CHARLES COPPOCK

Grosvenor Road, Highbury New Park, N., April 23

Waterton's Wanderings—Goat-suckers

ONE would like further information respecting the "nocturnal flies" which settle on the udders of cows or goats, and may be seen on moonlight nights. Many lepidoptera and coleoptera and a few hymenoptera are nocturnal, but are not known to adopt the habit described. Of the true flies, diptera, are any nocturnal?

HENRY H. HIGGINS

A STATUE TO CAPTAIN COOK

THE Australians have found a hero worthy of their worship, and Capt. Cook has at length found an English-speaking people eager to take occasion to honour the memory and the work of one of the greatest of Englishmen. The mystery of the reticence of our wealthy but unwieldy Geographical Society on the occurrence of the centenary of Cook's death, still remains unsolved; they did not even send a representative to Paris, to the amazement of the enthusiastic French geographers; was the weather too rough for the gallant admiral who we believe volunteered to the indifferent Council to go to the Paris meeting? We are glad for the credit of the nation that it has not been left entirely to the foreigner to recognise the greatness of one of England's greatest navigators and discoverers. Our readers may remember that some time since a statue of Cook adorned Waterloo Place, near the Athenæum Club. The statue was admitted to have been exceedingly happy in conception, and successful in execution; it is supposed to represent the great navigator coming within the loom of the east Australian coast, which he first saw near Cape Howe, to the south of Sydney. It was for this city that the statue was designed, and it was to inaugurate the work of Mr. Woolner, that on February 25 last one of the greatest demonstrations took place that has been witnessed in Australia since the first shipload of convicts was landed at Botany Bay. When we said that Australia had found a hero, perhaps we spoke too widely, for only New South Wales as represented by Sydney, seems to have joined in the demonstration to commemorate the centenary of Cook's tragic end and the unveiling of his statue. It seems to us a great thing for a people to have a worthy national hero, and since the days when Abraham begat Isaac, and probably long before, every nation of any note has had its hero or demigod in whom all the national virtues have been embodied. The Australians have the making of a great people among them, and while they have a right to count our gods as theirs, still no doubt they would like to have a Hengist of their own to mark a new starting-point in their history. Happily, as we have said, they have found a worthy one—one whose character is in every respect worthy of their admiration, and the principles of whose conduct, if adopted and acted upon, will help to make of them a really great people. However desirable we may think the federation of our Australian colonies to be, any advocacy of it in these pages would be out of place. Still we cannot but think that it would have been a good thing in many ways—a good thing for the colonies themselves, and conducive to cordiality among them—had they all united to do honour to one so worthy of honour in all respects, and to whom, in a sense, they are indebted for their very existence.

Nothing could have been more successful than the gathering in Sydney on February 25, to assist at the unveiling of the statue by Sir Hercules Robinson. It was a universal holiday. Probably there were not much less than 100,000 people gathered in and around Hyde Park at the time of the opening ceremony—people of all classes who had voluntarily given up their work or business for the day, apparently, to a large extent, from genuine enthusiasm towards the man who first landed near the site of what in a few years has become one of the finest cities in the world. The statue seems to have given universal satisfaction, and the enthusiasm reached its height when Sir Hercules Robinson unveiled it at the conclusion of a solid and suitable speech. In his address the Governor traced in a sympathetic manner the career of the hero whom they had gathered to honour, from his birth as a peasant's son, till his unfortunate murder at Hawaii. Sir Hercules does not, however, seem to be well up in the latest evidence with regard to Cook's death, and seems, as of old, to have attributed it to mere savagery, whereas it seems pretty clearly ascertained that it was a blunder on the part of the poor natives. We have so recently written on the character and work of Cook, that it is unnecessary again to go over the same ground. Sir Hercules very happily, we think, read the moral of Cook's life to the people of Sydney. He was a man who eagerly pursued knowledge as his scanty opportunities afforded: who valued science, and endeavoured to do all his work by its light and guidance; who treated those under his command with the greatest consideration, and exercised the utmost tenderness and humanity towards the natives of the various islands with which he had any dealings. "Such a statue is creditable to ourselves," Sir Hercules justly concluded, "as marking our admiration of the character and services of the man, and our gratitude for the benefits which his discoveries have conferred, not only on Australia, but also on the world at large. . . . There is scarcely a lad born in this country who has not within his reach educational advatages superior to those which were available to the poor Yorkshire peasant boy, and I hope that the history of his early life may not be thrown away upon the young, but that many a child in the future will learn at the foot of this statue how a faithful, patient, cheerful attention to the details of daily duty, however monotonous and commonplace, will bring its own reward, and may perchance, as in the case of James Cook, leave behind a noble and imperishable memory."

While we regard it as right and proper that this fine statue should have been erected in Sydney to Cook, we think, moreover, the people of New South Wales would only be carrying out the work of Cook if they took some step to obtain a more thorough knowledge of these Pacific islands and seas, for a knowledge of which Cook did so much. We recently referred to the lecture given them by Dr. Miclucho Maclay on the want of a zoological station at Sydney; and we would suggest that the people of Sydney, helped by the other Australian cities, should carry out the work they have so well begun, by founding an institution, that under proper guidance would add immensely to our knowledge of the life of these interesting

waters. Meanwhile let us be thankful that they have done something to redeem the race to which Cook belonged from the charge of insensibility to his greatness.

THERMO-CHEMICAL INVESTIGATION

THE introduction of a new method of research, or the invention of a new instrument, has repeatedly marked an epoch in the development of more than one branch of natural science. The last few years have witnessed the introduction into chemical research of a new method of examining chemical changes, a method which is founded upon the study of those thermal reactions which accompany these changes.

The older methods of chemical investigation failed to throw any definite light upon many important problems, some at least of which have been brought a step nearer complete solution by the application of the newer method of thermo-chemical measurement.

When solutions of two salts are mixed, the products of the mutual action of which salts remain in solution under the experimental conditions, it is frequently found impossible to determine, by means of the ordinary analytical processes, the chemical distribution of the mass of reacting matter at the expiry of the experiment.

Again, there are certain acids which undoubtedly form two series of well-marked salts, but which appear to be capable, under certain ill-defined conditions, of forming a third series of unstable saline derivatives. How to determine the basicity of such acids has long been one of the unsolved problems of chemistry.

Once more, the ordinary methods of investigation have failed to supply us with any far-reaching generalisation concerning the stabilities of series of compounds. Certain relations have undoubtedly been traced between general chemical properties of compounds, the properties of their constituent elements, and the stability of these compounds, but, nevertheless, the shadowing forth of well-marked generalisations, connecting stability of compounds with chemical structure, from which generalisations exact deductions, capable of experimental investigation, might be made, dates from the introduction of the thermo-chemical method of investigation.

That system of notation which is now employed in chemistry, although of the greatest value, is nevertheless far from being perfect; it fails to tell anything concerning the changes in forms of energy involved in those changes of distribution of mass which it formulates. Previous to the introduction of the thermo-chemical method little or no exact knowledge regarding these changes of energy was in the possession of chemists.

Chemists were long aware that certain reactions were possible only under stated conditions of temperature, pressure, &c., but until measurements had been made of the amounts of heat evolved or absorbed in these reactions they were unable to generalise the connection between the conditions of the reactions and the possibility of their occurrence.

Such are some of the problems which have been at least partially solved by the new method.

The fundamental position of thermal chemistry may be thus stated: "Every chemical change taking place without the aid of extraneous forces tends to produce that body, or system, in the formation of which the greatest evolution of heat occurs."

As a deduction from this statement Berthelot formulates his law of maximum work as follows:—"That salt, the formation of which is attended with the greatest evolution of heat, is always produced when those salts, from whose mutual action it may be formed, exist in solution in a condition of partial decomposition."

Many special instances illustrative of these generalisations might be cited; let one or two suffice. Chlorine decomposes dry sulphuretted hydrogen with formation of hydrochloric acid and separation of sulphur; iodine does not decompose sulphuretted hydrogen under the same conditions. The formation of hydrochloric acid and sulphur in the first change is accompanied with the evolution of a considerable quantity of heat; the formation of hydriodic acid and sulphur, in the second case, would involve the absorption of much heat. If, however, the action of extraneous forces be allowed to supervene, a new condition of equilibrium is attained; add water to sulphuretted hydrogen and iodine, hydriodic acid and sulphur are produced. But the solution in water of hydriodic acid, which is the potential product of the reaction, involves the evolution of more heat than is absorbed in the reaction itself.

Iodine scarcely decomposes water, but if sulphurous acid be added to water, iodine is capable of bringing about decomposition, the products of the reaction being hydriodic and sulphuric acids

$$(H_2O + I_2 + H_2SO_3 = H_2SO_4 + 2HI).$$

Now it is found that the formation of sulphuric from sulphurous acid is accompanied with the evolution of a considerable amount of heat; if, then, the decomposition formulated $2H_2O + 2I_2 = 4HI + O_2$ be started, the combination of the oxygen thus produced with the sulphurous acid present causes the evolution of more heat than would be evolved in any other series of chemical changes which could occur among the bodies present.

The applications of the thermal method in general chemistry are many and important. I propose briefly to consider some of the results obtained by this method, as shown in the phenomena attending the neutralisation of acids; in the changes which occur on mixing solutions of two salts which are capable of undergoing decomposition with the production of salts themselves soluble under the conditions of experiment; in the measurements of (so-called) affinities between elementary bodies; and in one or two other reactions of general interest.

The neutralisation of an acid by an alkali is attended with the evolution of a constant amount of heat; in some cases it is noticed that the total amount of heat evolved is independent of the relative quantities of acid and alkali employed, while in other cases the total heat evolution may be divided into two equal portions, one half of the whole accompanying the addition of the first portion, and one-half accompanying the addition of the second portion of alkali. Those results evidently point to the exhaustion of the available energy of the acid (or alkali) as a phenomenon which takes place in regular stages. The thermal results of neutralisation phenomena are rendered more intelligible when we find that an acid, the neutralisation of which is accompanied with the evolution of but one quantity of heat, is also a monobasic acid; while in the case of a dibasic acid the total amount of heat evolved on neutralisation with alkali is divisible into two distinct portions. Further, a difference is traceable between the thermal phenomena which attend the neutralisation of an acid by caustic potash or soda, on the one hand, and by ammonia on the other.

The reaction formulated

$$2KHO + H_2SO_4 = K_2SO_4 + 2H_2O,$$

involves the expenditure of 31,000 thermal units; but the reaction $2NH_3 + H_2SO_4 = (NH_4)_2SO_4$ is attended with the expenditure of but 28,150 thermal units

If, however, a compound more strictly comparable with caustic potash in its chemical structure be employed to neutralise sulphuric acid, we find that the heat evolved is equal in both cases; the reaction

$$2N(CH_3)_4OH + H_2SO_4 = (N(CH_3)_4)_2SO_4 + 2H_2O,$$

is attended with the evolution of 31,300 thermal units.

From the point of view of their thermal reactions, the alkalis (including thallium hydroxide) and the alkaline earths, are strictly equivalent, so far as the power of

neutralising one and the same amount of sulphuric acid is concerned.

The effect of substituting various compound radicles for the hydrogen of ammonia, is well shown in the phenomena attending the neutralisation of acid by ammonia, and by those substituted products. The introduction of a C_nH_{2n+1} group (C_2H_5, CH_3, &c.) into the ammonia molecule produces a substituted ammonia, the heat of neutralisation of which is the same as that of the parent body; but if a negative radicle (such as C_6H_5) be substituted for hydrogen, then a compound is produced in the neutralisation of which less heat is evolved than in the neutralisation of the parent body. Thus the neutralisation of hydrochloric acid by ammonia is accompanied with the evolution of 24,540 units of heat, while the neutralisation of the same acid by aniline ($NH_2C_6H_5$) is accompanied with the evolution of only 15,000 to 16,000 thermal units.

When solutions of two salts are mixed under conditions such that the products of their mutual action remain in solution, thermal measurements throw very considerable light on the progress of the chemical change.

The problem presented by the phemonenon now under consideration is one of those which are peculiarly difficult of attack by the older methods. If a third body were introduced into the mixture of salts, which should combine with, or render insoluble, one or more of the possible products of the action, a new configuration would be initiated, new chemical changes would probably occur, and we should be unable to say whether the results obtained were really trustworthy representations of the action which had taken place between the members of the original system.

But measurement of thermal changes involves no disturbance of the equilibrium of the reacting chemical system, and at the same time it yields trustworthy information regarding the changes which have occurred in the distribution of the mass of matter comprising that system. To take an example:—On adding a solution of potassium chloride to dilute hydrochloric acid no thermal change is noticed; on adding a solution of potassium sulphate to dilute sulphuric acid heat is absorbed, the amount of heat so absorbed increasing with the amount of acid added, until a limiting point is reached. If the solution of potassium sulphate be made more and more dilute less and less heat is absorbed. Now these facts evidently point to the occurrence of two processes of chemical change in the above reaction, viz., the direct action, formulated $H_2SO_4 + K_2SO_4 = 2KHSO_4$; and the inverse action, formulated

$$2KHSO_4 + H_2O = K_2SO_4 + H_2SO_4 + xH_2O$$

We are thus taught to regard this chemical change as dependent on the conditions of the experiment, and further we obtain a glimpse of the decompositions and recompositions which are continuously occurring among the molecules of our seemingly stable compounds.

If solutions of zinc acetate and sodium sulphate be mixed no thermal change is noticeable, but if solutions of zinc sulphate and sodium acetate be mixed, an evolution of heat occurs, that is to say, a chemical change (or a series of chemical changes) proceeds. Such an experiment as this, besides throwing light upon the special chemical change under consideration, leads to a clearer conception of those phrases "strong acid," "weak base," than were generally to be found before the introduction of the thermal method into chemistry. A strong acid is evidently an acid in the formation of the salts of which much heat is evolved, and a weak acid is one in the formation of whose salts little heat is evolved, or heat is absorbed. If therefore the heats of neutralisation of two acids by given bases be known, it may become possible to predict what chemical changes will occur when given salts of those acids are mixed.

Attempts have been made from time to time to measure the so-called affinities of the elementary atoms. These attempts have been considerably advanced, and the whole problem of affinity has been much defined by applying the results of thermal measurements to chemical reactions.

If chlorine be mixed with hydrogen, and the mixture be exposed to daylight, hydrochloric acid is produced with evolution of a large amount of heat; the formation of hydrobromic acid from its elements is accompanied with the development of less heat, while heat is absorbed in the formation of hydriodic acid from its elements. These thermal reactions show that more energy changes form in the first than in the second, and more in the second than in the third of these reactions. The amount of energy of motion which is convertible into thermal energy, under fixed conditions, seems, therefore, to measure the mutual affinities of chemical elements.

But we do not know what is the amount of energy spent in decomposing the molecules of hydrogen and chlorine; the heat developed in the reaction

$$2H + 2Cl = 2HCl$$

is therefore the sum of the plus and minus thermal changes during the cycle of chemical changes, the initial and final stages of which are chlorine and hydrogen molecules and hydrochloric acid molecules respectively. Therefore it is evident that thermal measurements do not give data which suffice for determining the absolute affinities of the elements.

If the elements comprised in a natural group be converted into similar compounds—say into oxides—and if that element in the formation of whose oxide the greatest amount of heat is developed be said to have the greatest affinity for oxygen, many remarkable relations may be shown to exist between the affinities and the atomic weights of the elements in such a series. Thus Thomsen has shown that in the group comprising magnesium, calcium, strontium, barium, the affinity for chlorine, bromine and iodine increases with increase of atomic weight, while the affinity of the haloid compounds of these elements for water decreases as the atomic weight of the elements increases. Many more exceedingly interesting results are brought out by Thomsen in the same paper.

The results of thermo-chemical investigation—a few of which I have endeavoured to sketch in thinnest outline—suggest one or two considerations regarding chemical action in general, and regarding some of those problems which yet remain to be solved by chemical science.

The older theory of chemical action is based upon the idea that the reacting bodies exert force upon one another; the word affinity has thus a positive meaning.

Recently the view has gained ground, with some chemists, that a chemical change is but the outward representation of a loss of energy occurring within the reacting system; that no positive force is exerted between the reacting molecules, but that the system, as it were, falls to pieces because the conditions are realised under which a loss of energy is possible.

The latter view, I think, fails to account for the facts; there is no doubt that it expresses a truth, but surely only a partial truth.

General considerations, no less than those derived from thermal measurements, compel us to regard the first action between two elementary molecules as consisting in a decomposition of those molecules with the production of their constituent atoms, which afterwards combine with the formation of new molecules. But the decomposition of elementary molecules involves the expenditure of energy; in other words, there is a mutual action and reaction between these molecules. If this stress be regarded from the point of view of one set of the reacting molecules only, we certainly have positive force exerted.

It is not a mere negative loss of energy, but a positive action of one kind of molecules upon another kind of

molecules; and the amount of force exerted is different for different elementary molecules. Hence chemical affinity is a positive force. The mutual action and reaction between the molecular systems involves the loss (or gain) of energy, but this loss of energy does not furnish a complete account of the action.

Thermal measurements enable us to determine the quantity of energy entering or leaving a given chemical system during its passage from one state to another. These measurements, therefore, give us most valuable information concerning the phenomena exhibited by those chemical systems.

The results obtained by these measurements show how great is our ignorance with regard to the progress of chemical reactions in general; and they suggest many exceedingly interesting problems which will doubtless ere long meet with satisfactory solution. The great problem of chemistry is to determine the connection between the structure and the properties of molecules. To take a special case, it may be asked, why is the hydrogen of acids replaceable by metals under definite conditions? Many facts are known which enable us to give partial answers to this question; doubtless, thermal investigation, taken in conjunction with other methods of research, will some day furnish the complete answer.

Thermal measurements have already shown us that allotropic changes in elementary molecules are accompanied with changes in the energy of these molecules and that the same generalisation holds good with regard to isomeric changes among compound molecules. But the whole question of allotropy is yet in its infancy.

The thermal method promises to throw light upon those phenomena which are classed together under the name of valency, and perhaps to furnish an answer to the query, *why* does the valency of elementary atoms vary? The new method is full of hopeful anticipations.

M. M. PATTISON MUIR

ARE THERE NO EOCENE FLORAS IN THE ARCTIC REGIONS?

IN NATURE (vol. xix. p. 124) I expressed doubt whether the beds containing fossil plants in or near the Arctic circle, said by Heer to be miocene, are really of that age. It seemed to me then very probable, but now I may say certain, that at least all those said to be *lower* miocene are truly eocene. The article was translated in *Das Ausland*, No. 2, 1879, and replied to by Heer in No. 8 (February 24) of the same journal. In this reply he, as I expected, combats my views, and, although affecting to believe that I had written without thought or previous study, he devotes eight columns to contradicting me, yet without bringing forward any fresh evidence whatever, or indicating any sources of information which I had not already consulted.

Heer contends that all the known fossil floras containing dicotyledons, from all lands within at least 2,000 geographical miles of the Pole, are either cretaceous or miocene. I think, on the contrary, many of them are eocene.

The leading facts for and against the hypothesis of a miocene age for so large a proportion of them may be briefly summarised.

1. The great similarity of the floras (miocene of Heer) of latitude 70° to those of 47° and 46°, 98 species out of 363, or more than 25 per cent. being common to both, even in the present state of our knowledge. This, according to existing plant-distribution, precludes their being of the same age, unless the more southern ones grew in Alpine or even hilly regions; but no one has ever contended that they did do so. No floras so much alike, and assimilating so closely to those of the present day, could have grown simultaneously at the same level in such widely different latitudes.

Against this Heer states that a number of trees extend from the borders of Italy to the 70th parallel, as the firs, birches, aspens, bird-cherry, and mountain-ash. This fact has little bearing on the subject, since the trees are Alpine, or, at least, not in any way characteristic of the lowland flora of North Italy or of that latitude in Europe. Secondly, he says that of the fifty-nine phanerogams found by Feilden in Grinnell Land between 81° 44′ and 83°, forty-five are European, and six of these are not only found in Swiss valleys, but also in Italy. This should not have been advanced, being quite beside the question, unless he wishes to make believe that the present floras of Grinnell Land and Italy resemble each other. They are, in fact, all Alpine herbaceous plants, and have nothing to do with the fossil *forest* floras in question; besides which, the level of the Swiss valleys in which these six grow is not stated, and there is nothing curious in Alpines ranging into Italy. Thirdly, of 559 species of phanerogams of the Isle of Saghalien, 188 are found in Switzerland. Such occasional examples of wide lateral distribution among plants are well known, and might often be adduced, without affecting the question in the remotest degree. The present distribution of the *same* types of plants, trees, &c., as those which are found fossil, have alone any bearing on the subject. Heer, to sustain his theory, must prove that forest floras extend in some other parts of the world with a much less degree of change than we have experience of in ou rcontinent, over not less than 30° of latitude, and in about the same longitude.

2. The extreme improbability that the plant remains of the eocene, a far more important formation than the miocene, should have been alone overlooked in a series of deposits abounding in plants of immense extent and thickness, and continuous, it is supposed, from the middle cretaceous to the upper miocene. The absence of any intelligent explanation of the complete break in the sequence, which Heer's nomenclature implies, and of which there is not the least stratigraphical evidence. The vastness and immense extent of the formations which are ascribed to miocene. The universally admitted fact that continuous land existed in the north between Europe and America from early eocene times, as proved by the palæontological records of both continents, and supported by other considerations, and which must have left records at least in proportion to those of the miocene, since volcanic, the preserving agency, was active throughout the whole time.

Heer characteristically meets these important objections by stating that at Eisfiord, in Spitzbergen, there are 1,000 feet of strata between the cretaceous and miocene, which he thinks doubtless represent the eocene. It is strange to find any one with the least knowledge of stratigraphical geology simple enough to advance such evidence as the presence of 1,000 feet of beds at a single spot, in dealing with so colossal an interval as that between the cretaceous and miocene, especially when the latter alone, over the area, is several thousands of feet in thickness. Besides Nordenskjöld,[1] from whom Heer derives his information, says that the miocene (of Heer) habitually rests upon the cretaceous.

Heer further says that there is a deposit with lower miocene mollusca under a miocene deposit. This is exactly what I should expect; for the same reasons that make it improbable that the flora is miocene apply equally to these mollusca.

3. The much higher temperatures which prevailed in the eocene than in the miocene, and which could only have permitted the growth of such temperate floras in such high latitudes in the eocene period, according to existing laws of plant distribution.

Although I showed *seriatim* that a mean temperature higher by 20° F. in the northern hemisphere would inevitably have produced approximately just the series of

[1] Excursion to Greenland, *Geol. Mag*, vol ix.

eocene floras that are met with in England, Iceland, Greenland, Spitzbergen, and Grinnell Land, and that from Heer's miocene standpoint no uniform increase could do so, his eight columns of reply do not embrace this question.

4. The total absence of any characters among the plants themselves, which would preclude their being considered eocene.

To this I must also await an answer until eocene floras are better understood. Heer's reply contains none.

It is obvious that if he has no more to say than this, the balance of the evidence, even as it stands, is already actually against him. But it is far more conclusive than I have represented it to be in the above summary.

We are told to believe that enormous deposits, many thousand feet in thickness, vast in extent, and resting everywhere conformably on the latest cretaceous beds, and indeed stratigraphically indistinguishable from them, are not as we should expect, in greater part at least—the next succeeding older tertiaries, but *the miocene*. We are not to question the reality of the marvellous gap thus created; not to point out that climatic considerations are entirely against the miocene age of the beds; not even to suggest that the plant evidence relied upon quite fails to support it; for Heer, like an infallible Pontiff, has, *on plant evidence*, pronounced them miocene.

He has tried to excommunicate me in his concluding paragraph, of which the following is but a feeble translation:—"The incorrect assertions and conclusions of Mr. Gardner proceed from want of knowledge or disregard of well-ascertained and solid facts, and it is much to be desired that those who occupy themselves with such difficult questions should first acquaint themselves with the facts before they express upon them such positive opinions."

I, however, to use a quotation, do not feel "one penny the worse."

The miocene hypothesis, which is not a scientific one, and would have been gladly overturned by Belt, rests entirely upon Heer's interpretation of the plants. I have therefore, I presume, but to show how completely unreliable in this case Heer's interpretation is, to break the spell of infallibility attaching to his work and to reopen the question for solution by scientific thought—"the application of past experience to new circumstances, by means of an observed order of events," as Clifford put it. In the first place, what are the "well-ascertained and solid facts" of Heer? I have looked at the Bovey Tracey beds formerly described, and erroneously, as miocene by Heer. Taking the ferns, with which I am just now most familiar, I find a form described as *Pecopteris lignitum*, and this species was at the time no doubt a "solid fact;" but I subsequently find Heer describes this *same* fern as *Aspidium lignitum*[1] and, extraordinary to relate, as *Dryandra rigida*.[2] Are these solid facts? Because he how speaks of the species as an Osmunda. I might analyse Heer's "solid facts" to a considerable extent, but refrain from doing so until the proper time arrives, in the pages of the Palæontographical Society. In the meantime I cannot but consider that his caution might more justly be applied to himself; for whilst I, at least, have had access to all Heer's published facts, I expressly stated that those I chiefly relied upon were unpublished.[3] I therefore marvel that he should have written so positively on so difficult a question without first, at least, endeavouring to acquaint himself with the latest facts.

Heer either does not possess, it appears, the knowledge requisite to separate stages of the eocene from the miocene, or he misapplies it. Of all the floras he has described but one is for him, eocene, and about this he expresses the greatest doubt. This single "great work"[1] on the eocene, as he calls it, was no larger than could be amply illustrated in ten not over-crowded plates, for I find the same species doing duty on more than one under different names. Beyond this he only claims to have studied the flora of Monte-Bolca, although he has published nothing upon it, and to have seen "many plants of the English eocene." Of the Monte-Bolca flora I can say little, as when I have been to Verona, where, I believe, large collections exist, the curator has been absent; but of the latter I can say that Heer's "many" must be used in a limited sense, for when he visited England, before either Mitchell or myself had commenced collecting, the collections open to him were meagre indeed.

Although, however, Heer modestly claims to have described but one eocene flora, I believe credit is due to him for describing several. Among these the most familiar to us is that of Bovey Tracey, lithologically and palæontologically precisely resembling some of the middle eocene beds of Bournemouth, only eighty miles distant from it.[2] Heer may, of course, deny their eocene age, and I cannot convince him by letting him see the specimens, as I did Ettingshausen, who, after being shown leaves, fruits, seeds, and spines, said the matter must be considered doubtful unless I could produce *Sequoia Couttsiæ* from Bournemouth. This, on looking through the cabinet of conifers, we found in abundance, not only from Bournemouth, but also from Alum Bay. This is but one instance selected from near home. If we look at Heer's tables in the third volume of his "Flora Tertiaria," we see that all the floras of France, Germany, Austria, Italy, and Switzerland are called miocene. The floras of Sotzka, Häring, Monte Promina, &c., although eocene to those who described them, are not so to Heer. He, in fact, persistently misrepresents the relative importance of the eocene and miocene formations, which he has always reversed, almost ignoring, indeed, the existence of the far more important of the two. Fortunately, accident has given to me what it has denied to Heer after a life of study, that is, access to large series of undoubted middle eocene plants; for my own collection, from Bournemouth alone, cannot number less than 10,000 selected specimens. These plants reveal how closely many of Heer's so-called lower miocene floras assimilate to the eocene, to which age they doubtless belong, and that forms thought to be characteristic of the former are really only met with in the latter, and that other species, ranging through both, are misleading and negative, so far as affording evidence upon this question. Of course Heer could not be acquainted with the unpublished English floras, and unfortunately their publication must be a work of time; but why, for example, in opposition to Unger and Ettingshausen, did he maintain the Sotzka, Häring, and Monte Promina floras to be miocene.

"When next you view,
Think others see as well as you."

is the moral of a fable with which Heer seems unacquainted.

I know that in very many cases what is lower miocene to Heer, is lower or middle eocene to me, and that therefore his *lower miocene* floras are practically and truly my *middle* or at latest *upper eocene* floras. There is thus a great difference of opinion between us, for the one nomenclature often implies immense gaps, which the other fills up.

While Heer's opinions of the ages of his localised floras are mostly based upon the evidence of the plants themselves, and the beds in which they are found contain little or no internal evidence, apart from this, of the formations to which they belong—those upon which I am

[1] "Sächsisch-thüringischen Braunkohlenflora," 1861, pl. ix. f. 2.
[2] *L.c.*, pl. x. f. 15.
[3] In course of publication by the Palæontographical Society.

[1] "Der sächsisch-thüringischen Braunkohlenflora," Berlin, 1861.
[2] *Geol. Mag.*, April, 1879.

at work are upon stratigraphical evidence *certainly* of the ages to which they are ascribed.

We have a limited Thanet sand flora; a considerable insight into the Woolwich and Reading Beds flora, obtained from Dulwich, Reading, Newhaven; an Oldhaven flora from Bromley; an extensive London clay flora from Sheppey; a Lower Bagshot flora from Alum Bay, Studland, and Corfe; a Middle Bagshot flora from Bournemouth and Bovey Tracey; upper eocene floras from Hordwell, Gurnet Bay, &c. All these will be embraced in the monograph now in course of publication by Ettingshausen and myself.

The nearly unbroken sequence seen in the eocene floras extends into the miocene. There is no great break in passing from one to the other when we compare them over many latitudes, and but little change, beyond that brought about by altered temperature or migration. If tertiary floras of different ages are met with in one area, great changes on the contrary are seen, and these are mainly due to progressive changes in climate. From middle eocene to miocene the heat imperceptibly diminished. Very gradually the tropical members of the flora disappeared; that is to say, they migrated, for most of their types, I think, actually survive at the present day, many but very slightly altered. Then the sub-tropical members decreased, and the temperate forms, never quite absent even in the middle eocenes, preponderated. As decreasing temperature drove the tropical forms south, the more northern must have pressed closely upon them. The northern eocene, or the temperate floras of that period, must have pushed, from their home in the far north, more and more south as climates chilled, and at last in the miocene time, occupied our latitudes. The relative preponderance of these elements, I believe, will assist in determining the age of tertiary deposits in Europe, more than any minute comparisons of species. Thus it is useless to seek in the Arctic regions for eocene floras, as we know them in our latitudes, for during the tertiary period, the climatic conditions of the earth did not permit their growth there. Arctic fossil floras of temperate and therefore to Heer miocene aspect, are in all probability of eocene age, and what has been recognised in them as a newer or miocene facies, is due to their having been first studied in Europe, in latitudes which only became fitted for them in miocene times.

When stratigraphical evidence is silent or inconclusive, this unexpected persistence and migration of plant-types or species throughout the tertiaries, should be remembered, and the degrees of latitude in which they are found should be well considered before conclusions are published respecting their age.

I need not here point out how completely this theory accords with that of the dispersion or migration of species from a northerly centre, so ably treated of by Asa Gray, Dawson, Dyer, Saporta, Hooker, and in fact by all who have pondered upon the subject, excepting Heer, for I hope to write a few words upon this at a future time. Before quitting it, for the present, Heer may as well learn that I am not alone in my opinions, for Prof. J. W. Dawson, of Montreal, considers with me that the reference of the beds in Greenland to miocene is not warranted by comparison with the tertiary plants of America.

"Immediately above these upper cretaceous beds we have the great lignite tertiary of the west—the Laramie group of recent American reports—abounding in fossil plants, at one time regarded as miocene, but now known to be lower eocene, though extending upward toward the miocene age. These beds, with their characteristic plants, have been traced into the British territory north of the 49th parallel, and it has been shown that their fossils are identical with those of the McKenzie River Valley, described by Heer as miocene, and probably also with those of Alaska, referred to the same age. Now this truly eocene flora of the temperate and northern parts of America has so many species in common with that called miocene in Greenland, that its identity can scarcely be doubted. These facts have led to scepticism as to the miocene age of the upper plant-bearing beds of Greenland, and more especially Mr. J. Starkie Gardner has ably argued, from comparison with the eocene flora of England and other considerations that they are really of that earlier date." [1]

Private correspondence has already informed me that others now share in these views.

Not content with withering my theories as to the eocene age of part of his miocene Arctic floras, Heer tilts against my explanation of the former higher temperatures which are known to have prevailed in our own and more northern latitudes. My explanation is, however, justified by our experience of what we conceive to be natural laws, and does not contradict that experience, and Heer has no theory to set up in its place.

The differences in the temperatures of the seas washing Arctic lands in the same latitudes are seen to alter the isothermal temperatures of their coasts to the extent of 27°; that is to say, the coasts which are refrigerated by the descending ice-laden currents are 27° colder than the shores of the North Cape, which are washed by an ascending current. With this fact and its causes palpably before us, we are justified in inferring that if the cold currents were shut off from these coasts, their temperature would rise by some 27°. The cold currents *were* shut off in the eocene time, for plants and animals passed freely between Europe and America, and therefore the temperature of the northern eocene lands may have been *from this cause* some 27° higher. But the Arctic eocene floras only required about 20° higher temperature, and the cause invoked is therefore more than sufficient.

Heer agrees with me that the higher temperature at the North Cape is due to warmer sea, and that continents extending far south also have their influence. He objects that Spitzbergen, being within the influence of the Gulf Stream, has a temperature of only 7° above the mean of its latitude. But then Spitzbergen is not shut in by the Gulf Stream, but only washed along one shore by it, and that after its current had been enfeebled and refrigerated to the last degree by the icy water it has to press through. Yet slight as the cause then is, it raises the isotherm of Spitzbergen 7°. He again objects that the closing of these outlets would stop the flow of the Gulf Stream. This, however, would not be the case completely. As long as any difference existed between the temperature to the north, and that under the tropics, a circulation would continue and would only cease when the whole Atlantic, north of the Equator, had reached a uniform heat. Not streams only, but the whole Atlantic from the Equator northwards, would be enormously warmed, and even parts of continents most remote from seas, would feel the influence.

This theory if true, Heer says, is at all events not original. In that case, so much the more likely to be true, but it is original to me.[2] It is true that very many theories have been put forward to account for former temperatures, and some of these have been based upon altered distributions of land and sea. But while some required change in the level of the sea, and others involved entirely novel continental areas, none have been supported by any kind of proof, either that the supposed changes had actually taken place, or were even competent to account for the former temperatures. The theory I have ventured to put forward is only absurd in its simplicity. The Atlantic may be likened to a great bath heated by the sun, from which we may shut off the cold taps either partially or entirely, from one or from both ends, thereby producing

[1] "The Genesis and Migrations of Plants," by J. W. Dawson. The *Princeton Review*, 1879, p. 282.
[2] NATURE, vol. xix. p. 123.

any known gradation of sea temperature. It not only accounts for the eocene heat when the land in the 70th and 80th parallels was upheaved by enormous volcanic action; the cooler miocene brought about when this action subsided, and permitted Arctic seas to again find egress; and the cold glacial period when both shores of the Atlantic were frozen by icy currents, as one shore is now; but by shutting off Antarctic currents it might have produced the hottest cretaceous times. Even the latter supposition is rendered likely by the past and present distribution of life, and such conditions doubtless did exist in remote times.

I am, however, speculating beyond the scope of my present paper, for, however the eocene climate was produced, the Arctic floras, I believe, flourished in it. Again I will close my paragraph with an extract from Dawson:[1] "But overlying this plant-bearing formation we have an oceanic limestone (the Niobrara) . . . . indicating that the land of the lower cretaceous was replaced by a vast Mediterranean Sea, filled with warm water from the equatorial currents, and not invaded by cold waters from the north. This is succeeded by thick upper cretaceous deposits. . . . these show that further subsidence or denudation in the north had opened a way for the Arctic currents, killing out the warm-water animals of the Niobrara group, and filling up the Mediterranean of that period."

J. STARKIE GARDNER

[1] The *Princeton Review*, 1879, p. 282

AN ENGLISH MICROSCOPE FOR THE USE OF STUDENTS OF MINERALOGY AND PETROLOGY

IT may interest those who are studying petrology to know that a new microscope, specially suited for mineralogical and petrological research, has recently been constructed by Mr. T. W. Watson, of Pall Mall.

For several years past students have frequently asked me to recommend some microscope to them which would answer their requirements, and, finding that none of the cheaper instruments manufactured in this country were supplied with concentrically-rotating stages, bearing divided circles, and that even the high-class instruments failed to fulfil all the requirements, it appeared that this want might be supplied at a moderate cost, if one of our instrument-makers could be induced to make a few trials.

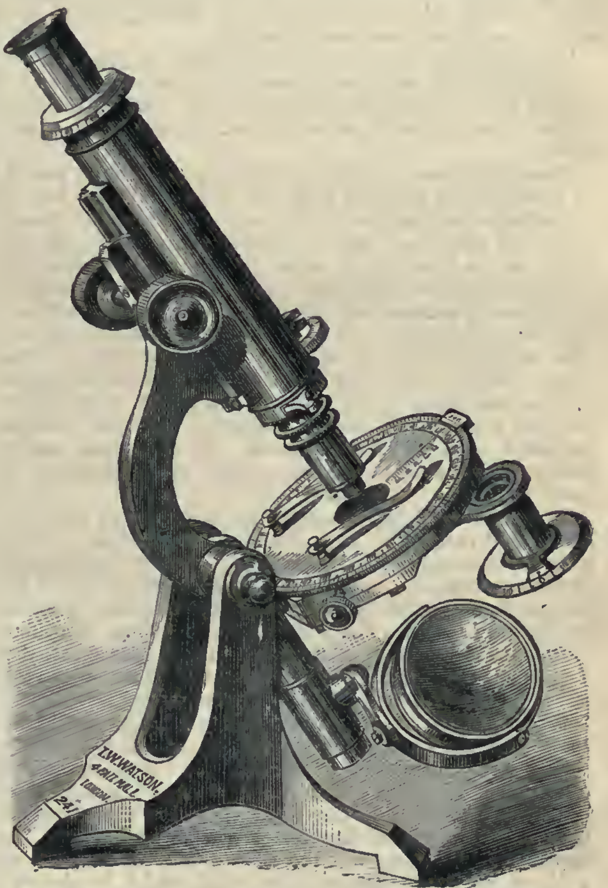
An examination of one of the microscopes devised by Prof. Rosenbusch and manufactured by Fuess, of Berlin, showed me that, although that instrument possessed many features of great merit, it also had certain defects which could be best overcome by adopting and modifying a good English model.

The great defects in most of the microscopes built on the continental patterns consist in their fixed vertical position, the smallness of their stages, and, very commonly, in the absence of any means of coarse adjustment, except by a sliding movement of the body or tube, which, if working stiffly, is very inconvenient, while, if sliding easily, is apt to be shifted by a very slight touch.

The microscope of Prof. Rosenbusch, apart from one or two of these defects, is a very admirable instrument, and presents various advantages over all other microscopes hitherto made.

The instrument, now manufactured by Mr. Watson, is in most respects quite equal in performance to Rosenbusch's microscope, so far as the mechanical appliances and adjustments are concerned, and is, I think, in point of convenience, decidedly superior to the latter instrument.

The foot is a brass casting of a pattern somewhat similas to that of Ross and other well-known makers. Upon this a gun-metal limb is supported on trunnions, which constitute the axis upon which the limb turns, so that the instrument can be inclined at any angle, or placed in a horizontal position for drawing. The right trunnion carries a clamp to fix the instrument at any angle. The lower portion of the limb bears the mirror, attached to a jointed arm. The upper part of the limb is bowed, or goose-necked, which renders it convenient as a handle, by which to lift the stand, without entailing any strain upon the working parts of the instrument. Above the curve it is ploughed out to receive the rack of the body or tube (on the pattern known as the "Jackson Model"), and the coarse adjustment is effected by a pinion turned by milled heads. The fine adjustment is of the usual kind, and is situated near the lower extremity of the tube. In the stand first made the milled head of the fine adjustment was divided for the measurement of the thickness of sections, but in future it is proposed to effect this object in a different manner by divisions engraved upon the limb and the sliding portion of the coarse adjustment.



The head of the tube or body carries a bevelled disk which is divided to 10° spaces. A corresponding disk with an index is attached to the bottom of the analyser-fitting, and rests directly upon the fixed divided disk; so that the analyser can be set in any required position, and any amount of revolution imparted to it can also be registered. The eye-piece, when inserted, is kept in a fixed position by a stud, which falls into a small slot. Crossed cobwebs are fixed within the eye-piece for the purpose of centring the instrument. A small plate of calc-spar, cut at right angles to the optical axis, is mounted in a little metal ring, which can be placed between the eye-glass and the analyser for stauroscopic examinations.

At the lower end of the microscope-tube a slot is cut to receive a Klein's quartz plate or a quarter-undulation plate, both of which are set in small brass mounts. When these are not in use the aperture can be closed by means of a revolving collar.

The thread which receives the objectives is of the gauge commonly used in this country, but an adapter can also be supplied which will carry the objectives of Hartnack and other continental opticians.

The stage is circular and capable of rotation, and it is divided on the margin to 360°. A vernier is attached to the front of the stage, giving readings to one minute. The edge of the stage is milled, and rotation is imparted by hand.

To insure concentric rotation with any powers used, two screws, carrying milled heads, are connected with the back of the stage. By the employment of these adjusting screws and the cobwebs in the eye-piece, a small object may readily be centred, so that it will revolve about a point central to the field afforded by any objective.

The object is held either by sliding clamps or by spring clips, and is moved about by hand. With a little practice this simple method of moving the object will be found to answer every purpose.

The polariser slides into a fitting which is fixed to an arm pivotted on the lower, movable surface of the stage, so that it can readily be displaced when ordinary transmitted illumination is required, and replaced with equal facility.

Two little lenses, affording a strongly-convergent pencil of light, are set in metal rings which drop into the top of the fitting which surrounds the polarising prism. When these are employed and the analyser is used, without lenses in the eye-piece (a separate fitting is supplied for this purpose), examinations of the rings and brushes, presented by sections of certain crystals, can be advantageously carried on, and a quarter-undulation plate can also be employed when needful. The lower end of the fitting which carries the polariser is surrounded by a divided disk, turning beneath a fixed index, so that any position of the prism can be recorded and the rotation imparted to it can be measured. Several other useful pieces of apparatus can be added to the stand at a moderate cost.

From the foregoing description it will be seen that this instrument is capable of performing the functions of an ordinary microscope, a polariscope, a stauroscope, and, to some extent, a goniometer. A spectroscope could be fitted to it if needful, as well as an apparatus for heating sections of crystals. For a few pounds separate binocular tubes can be supplied, to replace, in a few seconds, the single, but more generally useful, tube. The objectives of any maker can be used with the instrument.

Having carefully tested one of these microscopes I can speak most favourably of its performance. It is strongly constructed, convenient to handle, and the adjustments work very smoothly. The price of this stand is also remarkably moderate when compared with that of many microscope-stands of far less universal application. It appears to me well qualified to answer the requirements of students of mineralogy and petrology, and it is also applicable to other studies for which microscopes are commonly required.

Mr. Watson has taken especial pains to turn out a sound and serviceable instrument, and, after long experience of microscopes, I can confidently say that I have never seen one better suited for the work for which it is designed.

FRANK RUTLEY

STELLAR MAGNITUDES

A REQUEST TO ASTRONOMERS

THE scales adopted by different observers in their estimates of stellar magnitudes differ considerably from each other, as is well known. As regards the brighter stars, these differences, indeed, are comparatively unimportant; but they become larger and more perplexing when the objects observed are faint. Variations of three or four magnitudes may be expected between the estimates made of the brightness of minute companions seen near a brilliant star. It is needless to point out the inconvenience of this state of affairs, which at times nearly deprives the estimated magnitudes, found in catalogues, of their meaning, and consequently of their value.

In the hope of providing a partial remedy for this defect, a series of photometric observations of stars of various magnitudes, situated near the north pole, has been undertaken at the Harvard College Observatory. The region has been selected as one which may always be conveniently observed in the northern hemisphere, so that the brightness of a star observed in another part of the sky can readily be compared by estimate with any standard polar stars, the relative brightness of which may have been determined by photometric measurements.

The table and chart given below are designed to serve as guides in finding the stars which are, as has been said, in course of phonometric measurement at the Harvard College Observatory. The stars given in the table are arranged approximately in the order of their brightness, the first being α Ursæ Minoris, which is taken in all cases as the standard of comparison, and the next three, δ Ursæ Minoris, 51 Cephei, and λ Ursæ Minoris. The chart is a copy of a sketch showing the approximate relative position of ten faint stars very near the pole, which are denoted by the italic letters *a, b, c, d, e, f, g, h, k, l.* The places

DM. ° ′	α 1880. h. m.	δ 1880. ° ′
88 8	1 14	88 40
86 269	18 11	86 37
87 51	6 44	87 14
88 112	19 44	88 57
88 4	0 51	88 23
88 9	2 3	88 36
89 3	2 28	89 36
89 35	17 50	89 48
89 37	19 28	89 54
89 1	0 19	89 45
89 26	13 23	89 49

of the pole for 1855, 1880, and 1900, and of five stars from the Durchmusterung, four of which occur in the table, are also indicated upon the chart, to facilitate the identification of the faint stars. The objects called *c* and *e* are nearly in the prolongation of the line through DM. 89° 37′ and *b*. Between these last, and more nearly in the same line than it appears to be in the chart, lies the star *a*.

The value and interest of the photometric results to be obtained at the Harvard College Observatory may be greatly increased by the co-operation of astronomers elsewhere. All who are desirous of improving the present

system of comparing the brightness of stars, are therefore requested to make estimates of the magnitude of as many as may be convenient of the stars above mentioned. It is desirable that the estimate should be made, for each star which may be observed, on five different nights, and that each estimate should be, if possible, entirely independent of those previously made. It will add to the value of the work if, on every occasion when the fainter stars are looked for, a record is made of such of them as can then be seen, even if no estimate of their magnitude is attempted.

Observers are also requested to note the approximate places of any stars not represented upon the chart, but within five minutes of the place of the pole at any time between 1880 and 1900. The boundary of this region is represented on the chart by a dotted line. The stars not shown within it have been omitted as unnecessary for the purpose of finding the others, and several of these omitted stars are inconveniently faint for photometric observations; but records of their visibility at any time and place will be valuable as evidence of the state of the atmosphere and character of the instrument employed in the observations.

All astronomers who may be induced by this request to make any observations of the kind just described will confer a favour upon the Harvard College Observatory by sending to it a copy of their records, accompanied by a statement of any modification of the proposed method of observation which they may have adopted, as well as any additional details which may appear desirable, with regard to the instruments employed, &c. Unless the contrary is requested, the results will be published with the photometric measurements obtained at the Harvard College Observatory; and a copy of the publication will be sent to each observer who has co-operated in the work.

It is hoped that a large number of those astronomers whose experience has been sufficient to establish a definite scale for their estimates of stellar magnitude will consent to take part in the proposed observations, in order that the published series of observations may be complete enough to be of general utility.

EDWARD C. PICKERING
Director of the Harvard College Observatory

GEOGRAPHICAL NOTES

AT the meeting of the Royal Geographical Society on Monday evening it was announced that the gold medals had that day been awarded to Col. Nicholas Prejevalsky for the great additions he has made to our knowledge of Central and Eastern High Asia by his successive expeditions into the unexplored parts of the great plateau of Mongolia and the lofty deserts of Western Thibet, and for the admirable way in which he has described the regions traversed by him in the published narratives of his journeys; and to Capt. W. J. Gill, R.E., for excellent geographical work performed during two journeys of exploration, voluntarily undertaken, along the northern frontier of Persia in 1873, and over previously untravelled ground in China and Thibet, in 1877; also for the elaborate memoir and route maps contributed to the forthcoming volume of the Society's *Journal*. A paper was afterwards read by the Rev. James McCarthy, of the China Inland Mission, descriptive of the journey which he made, mostly on foot, in 1877, across China, from Chinkiang, on the Yangtsze-Kiang, to Bhamô, in Burmah. The leading features of this journey have been fully described in NATURE. The most noteworthy incident of the evening was a speech, delivered in his native language by the Marquis Tsêng, Chinese Minister to England and France, expressive of the pleasure which he felt at Mr. McCarthy's acknowledgment of the uniformly courteous treatment he experienced during his long journey.

AT the next meeting of the Geographical Society on May 12, the second of the course of scientific lectures of the present session will be delivered by Prof. G. Rolleston, of Oxford, on the "Modifications of the External Aspects of Organic Nature produced by Man's Interference."

NEWS has arrived by the last mail from Zanzibar that Mr. H. M. Stanley is busily occupied in engaging porters for a journey into the interior of Africa, but that he preserves the utmost secrecy as to his intended movements. A rumour is current amongst the porters that their journey is to commence from the west coast; if this be the case, Mr. Stanley must have introduced a radical change into the original plans of the Belgian section of the International African Association, for whom he is believed to be acting. That, accidents apart, he will be more successful than the unfortunate leaders of the first Belgian expedition few will be so rash as to doubt, and he is sure to have good and sufficient reasons for the course he is adopting.

DURING the past few days there has been a considerable exodus of missionary explorers. Dr. James Stewart, the well-known head of the Livingstonia station, has returned to his post, and will soon be adding more to our knowledge of the shores of Lake Nyassa. Dr. Joseph Mullens, of the London Missionary Society, who has already done good service to geography in Madagascar, has started for Ujiji, on Lake Tanganyika, and before returning home he will probably make his way down to the north end of Lake Nyassa, thus filling up an important blank in our knowledge of the lake region. Lastly, the Rev. T. J. Comber, of the Baptist Missionary Society, has returned to Western Africa to found a station at San Salvador, and eventually to conduct a missionary expedition to the upper waters of the River Congo.

THE general report of last year's operations of the Marine Survey of India, under Commander A. Dundas Taylor, late I.N., has just reached this country. During that period two parties carried out the following surveys: Ratuagiri, including Mirya and Kalhadevi Bays; Viziadurg, including Rajapur and Ambol Ghur Bays; Paumben Pass (between Ceylon and the mainland) and its approaches; Beypore, Calicut, and Cochin. The natural history investigations of the season have been confined to an examination of the fauna inhabiting the shores in the vicinities of Ratnagiri and Viziadurg, and to the collection and preservation of the various ornithological specimens procured. The area examined includes the tract of country lying between the above places from the sea to the chain of hills known as the Western Ghâts. The examination of the sea-bottom with the dredge was impracticable, owing to the want of a vessel; this want, however, has since been supplied, as was recorded in NATURE, vol. xix. p. 298, and no doubt interesting results will be obtained during the present season. Captain Taylor's report is accompanied by a useful map showing the surveys completed by his officers, together with the sheets published or in course of publication, 1877-8.

THE second session of the Congress of Commercial Geography, inaugurated at Paris last year, will be held at Brussels in September, under the presidency of M. Bamps, and arrangements for the meeting have already been commenced.

NEWS has been received from Queensland that the remains of the two Prouts, well-known explorers, have at length been discovered, so that the question of their fate is now finally set at rest.

AT the last meeting of the Société de Géographie Commerciale at Paris Dr. Harmand gave some account of his observations in the Laos country of the Indo-Chinese peninsula. He stated that though elephants were common there, ivory was dearer than in Paris, and that the same remark applied to rhinoceros-horn. There are mines of lead, iron, and copper in the country, and probably gold

will be found. The chief productions are indigo, lacquer, saffron, rice, cotton, &c., but the industry of the country is in a very undeveloped state.

A NEW project for the creation of an inland sea has been advanced and advocated by General Fremont, at present Governor of Arizona. The removal of a barrier ridge, he affirms, would admit the waters of the Gulf of California into an ancient basin, and would create a navigable inland sea 200 miles long, 50 miles broad, and 300 feet deep. This piece of engineering, which is very like Roudaire's Algerian inland sea project, he claims, would convert what is now a desert region into a commercial highway, and would greatly improve the climate of Southern Arizona and California.

AT last week's meeting of the Paris Academy M. de Lesseps announced that in a letter of April 15, Capt. Roudaire states that the sounding operations were being pursued with vigour and success, and that so far they justified the expectation of being able to create an interior Algerian Sea.

AN exploring expedition to New Guinea is being organised at Wellington, New Zealand, on a large scale.

L'Exploration states that a new African expedition is being organised at Lisbon, under the direction of Capt. Paiva d'Andrada. Its object is the exploration of the Zambezi and the foundation of commercial and agricultural colonies in the territories of Fete and Zoumbo.

IN the *Verhandlungen* of the Berlin Geographical Society, Nos. 2 and 3, is a suggestive paper by Dr. Güssfeldt on the Ice-Conditions of High Mountains. No. 80 of the *Zeitschrift* contains a paper of much originality, on the causes which have conduced to the formation of the surface of Norway, by Prof. Kjerulf.

Globus is publishing a valuable series of articles on the Red River of the North, from the French of M. de Lamothe, and the Hundu Kush Alps by Herr Emil Schlagentweit.

NOTES

THE Annual London Meeting of the Iron and Steel Institute will be held on Wednesday, Thursday, and Friday, May 7, 8, and 9, at the Institution of Civil Engineers, 25, Great George Street, Westminster. The following programme of proceedings has been arranged :—On Wednesday the retiring President (Dr. C. W. Siemens, F.R.S.), will take the chair at 10.30 A.M., and the President-Elect (Mr. Edward Williams) will deliver his inaugural address. The Bessemer Medal for 1879 will be presented to Mr. Peter Cooper, of New York, "the father of the American iron trade." The adjourned discussion on the paper read at Paris by Mr. Daniel Adamson, C.E., of Manchester, on "The Mechanical Properties of Iron and Mild Steel," will be resumed, and Mr. Adamson will present a supplementary paper. On the following days the following papers will be read and discussed :—"On the Use of Steel in Naval Construction," by Mr. Nathaniel Barnaby, C.B., H.M.'s Chief Constructor. "On the Use of Steel in the Construction of Bridges," by Mr. H. N. Maynard. "On the Elimination of Phosphorus in the Bessemer Converter," by Mr. Sydney G. Thomas, F.C.S., and Mr. Percy C. Gilchrist, A.R.S.M., F.C.S. "On the Removal of Phosphorus and Sulphur during the Bessemer and Siemens-Martin Processes of Steel Manufacture," by Mr. G. J. Snelus, F.C.S., &c. "On a New Volumetric Method of Determining Manganese in Manganiferous Iron Ores, Spiegeleisen, Steel, &c.," by Mr. John Pattinson, F.I.C., Newcastle-on-Tyne. "On a Ready Means of Moulding Lime, and making Lime or Basic Bricks and Linings for Furnace Converters, &c.," by Mr. Edward Riley, F.C.S., F.I.C., &c. "On a Practical Combination of the Bessemer and Puddling Processes," by Mr. Edwin Pettitt, Cheltenham. "On the Results of Working the Godfrey-Howson Furnaces at the Works of Tamaris, Gard, France," by M. Escalle. "On the Chemistry of Puddling," by Mr. H. Louis, A.R.S.M., Londonderry, Nova Scotia. "On a New Process for Protecting Iron and Steel against Rust," by Prof. Barff.

THE Rev. W. H. Dallinger, F.R.S., has been appointed Rede Lecturer at Cambridge this year.

AMONG those on whom the degree of LL.D. has been conferred by the Glasgow University is Dr. C. W. Siemens, Prof. Hull, director of the Irish Geological Survey, and Prof. Dickson, newly elected to the Edinburgh Chair of Botany.

THE death is announced of Dr. Charles Murchison, F.R.S.

MADEMOISELLE ADELAÏDE MONTGOLFIER, a daughter of the inventor of balloons, is still alive, aged eighty-nine years. She is possessed of a large fortune, and presented the Museum of the Aëronautical Academy with a copy of the large medal executed by Houdon, and representing her father and uncle, who was associated with him in the invention of balloons. This medal was executed to commemorate that event. A movement will be got up in France for celebrating the centenary of that memorable event, which took place in June, 1783, in the vicinity of Lyons.

THE annual conference on National Water Supply, Sewage, and Health, will be held in the rooms of the Society of Arts, on Thursday and Friday, May 15 and 16, 1879. There will be an Exhibition of Mechanical and Chemical Apparatus in connection with Water Supply, Treatment of Sewage, and Health. Papers on any of above heads are requested. The object of the conference is to discuss existing information in connection with the results of any systems already adopted in various localities, referring to the subjects of National Water Supply, Sewage, and Health; to elicit further information thereon; and gather and publish, for the benefit of the public generally, the experience gained. The introduction and discussion of untried schemes will, therefore, not be permitted. The papers accepted for the conference will be printed and circulated at the meetings.

PROF. TYNDALL has been instructing the Select Committee appointed to inquire into the subject of electric lighting. He gave a brief sketch of the history of electricity and of its application to lighting purposes, illustrating his evidence by several interesting experiments. Seeing what had been done by Mr. Edison, he believed that many of the existing difficulties would be removed; for public illumination he was afraid platinum would be too expensive. Dr. Siemens has also been giving important evidence on the subject.

WE are glad to see that Dr. Brehm, the well-known naturalist, accompanies the Crown Prince of Austria in his tour through Spain.

WE learn from *Science News* that the Brazilian Government has appointed Mr. Orville A. Derby as geologist to the National Museum at Rio de Janeiro, to succeed the late Prof. Hartt, whose assistant Mr. Derby had been for a number of years. Next to Prof. Hartt, Mr. Derby was probably best acquainted with the geological structure of Brazil, and he is, therefore, the one most fitted to carry on the work. He accompanied Prof. Hartt, as an assistant, on both of his Amazonian trips, in 1870 and 1871, and largely shared in the honours arising from the discoveries made during those years, by which a firm foundation was laid for the complete geological exploration of the great valley.

THE following arrangements have been made for the meetings of the Society of Arts after Easter :—At the ordinary meetings on Wednesday evenings, at eight o'clock: May 14—"The Automatic Hydraulic Brake," by E. D. Barker; May 21—"Edison's New Telephone," by Conrad W. Cooke. In the African Section, on Tuesday evenings at eight o'clock: May 27—"The Contact of Civilisation and Barbarism in Africa, Past

and Present," by Edward Hutchinson. In the Chemical Section, on Thursday evenings, at eight o'clock: May 8 and 15—"The History of Alizarine and Allied Colouring Matters, and their Production from Coal Tar," by W. H. Perkin, F.R.S. In the Indian Section, on Friday evenings, at eight o'clock: May 2—"The Wild Silks of India, especially Tussah," by Thomas Wardle; May 23—"The Harbour of Kurrachee," by W. J. Price.

A SPECIMEN of the electro-magnetic engine invented by M. Marcel Deprez is employed by the Academy of Aëronautical Ascensions, 50, rue Rodier, Paris, for working a sewing-machine which is used for the construction of a balloon called *L'Électricité*. The weight of the motor is only 4 kilogrammes, and four Bunsen elements of ordinary size are sufficient to give to the needle the required velocity.

FROM to-day postal cards will be sold in Paris at the price of 50 centimes each, for the transmission of messages by the pneumatic tube which connects the several telegraphic stations in the French metropolis.

IN a memoir presented to the Academy of Sciences and Literature of Lyons, we learn from the *British Medical Journal*, Dr. Henry H. Dor, a well-known oculist, contests the view held by Mr. Gladstone, and by Geiger and Magnus of Boston, that our ancestors were colour-blind, a view deduced from their writings and from the different names which they have given to colours. Dr. Dor endeavours to demonstrate that now, as in the time of Homer, poets insist too little upon the indications of the colours, but much more upon their luminous intensity. Moreover, Dr. Dor says that persons who do not possess any knowledge of physics find much difficulty in distinguishing the colours of the rainbow, and only see in it three or four colours, in place of the seven classical colours of its composition. Further, it results even from the very study of the Assyrian and Egyptian monuments, that those nations had not only perceived, but imitated, the greater part of the colours of which we are at present cognisant.

THE second annual meeting of the Midland Union of Natural History Societies will be held in the council chamber of the Town Hall, Leicester, on Tuesday, May 20, at half-past three o'clock. The business of the meeting will be to receive the report of the Council and the treasurer's accounts; to fix the place of the next annual meeting in 1880; to consider any suggestions that members may offer; to discuss the work of the Union during the coming year; and to transact all necessary business. The President will open the business with an address. A *conversazione* will be held in the Leicester Town Museum (entrance in Hastings Street) on Tuesday evening, May 20, the arrangements for which are under the direction of the Leicester Literary and Philosophical Society. There will be an exhibition of objects of general scientific interest, microscopy, the various departments of natural history, archæology, and art. On Wednesday, May 21, there will be an excursion to Charnwood Forest.

FROM the *Gardeners' Chronicle* we learn that an Agricultural and Horticultural Society has been founded at Mentone, many of the members being English residents.

THE *Electrician* of April 26 contains a long letter from Prof. Clerk Maxwell on the correct definition of "Potential."

AMONG Mr. Murray's list of announcements is "The River of Golden Sands," a narrative of a journey through China to Burmah, by Capt. William Gill, R.E., and "A History of Ancient Geography," by E. H. Bunbury.

THE *American Naturalist* for April contains a curious paper, by Mr. Xenos Clarke, on "Animal Music, its Nature and Origin." Mr. W. O. Crosby has a paper on "Native Bitumens and the Pitch Lake of Trinidad," and Mr. W. H. Holmes on a Deposit of Obsidian in the Yellowstone Park.

GRAVITATION experiments in liquids have recently been made by Herr Schröttner in Vienna, with a view to determining viscosity (as previously proposed by Pisati and De Heen). He took as basis a formula of Stokes for the resistance of a ball moved in a straight line in a liquid, and sought to determine the coefficients of friction in absolute measure. The practicability of the method was proved in a very viscous mixture of black pitch and beech-tar, and in concentrated glycerine. For the latter, higher values were obtained than by the transpiration-experiments carried on at the same time. From the author's experiments with glycerine, as also from Schieck's gravitation experiments with water, it appeared that the coefficients of friction were considerably greater whenever the velocities of fall exceeded a certain amount. For liquids with little viscosity, as water, small velocities of fall, such as met the conditions of experiment, could only be obtained by giving the balls a surplus weight of a few hundredths of a milligramme over the displaced mass of liquid, in case experiments were not made with very large balls and very considerable quantities of liquid.

ROMAN remains have just been discovered at Oberbreisig, a village near the Rhine, a few miles to the south of Bonn. A rectangular building of unquestionably Roman origin has been laid bare, the purpose of which, however, is very doubtful. The excavations leading to this discovery are in connection with others of greater extent which are being made in the neighbourhood, and which are principally directed to the investigation of a Roman villa near Waldorf and a Roman road leading to Sinzig.

IN a recent memoir communicated to the Belgian Academy, M. Lagrange offers some novel views on the formation of bodies in the universe. He supposes that before any expenditure of work the quantity of heat of the universe was *nil*, and that the temperature was gradually raised above absolute zero at the expense of work done by attraction. Hence the formation of solid bodies must have preceded that of liquids and gases. Through the gradual condensation of matter and consequent enormous development of heat, the earth would attain, at least in the parts near the surface, the state of fluidity necessary to explanation of its form and geological characters. As the temperature gradually rose with gradual agglomeration of matter, a very dense atmosphere would form, with pressure diminishing outwards, and in a more advanced phase, the temperature of this, after reaching a maximum, would gradually diminish, causing liquefaction or solidification of certain matters at first vaporous, while other solid bodies might remain suspended in the atmosphere. M. van der Mensbrugghe commends the author's views as original and worthy of the attention of *savants*, but, with M. Folie, he regards the initial absolute zero as inadmissible. In reply to objections by M. Folie, the author promises shortly to defend this hypothesis:—Space is occupied by two substances; one, attractive, which is matter properly so-called, or material atoms; the other, repulsive, which occupies the inter-atomic space, and from which results, between any two atoms, a variable repulsion exercised at the surface of the latter.

WE have received No. 11 (March, 1879) of the *Bulletin* of the Brooklyn Entomological Society, of the existence of which publication we were not previously aware. It consists of a half-sheet 8vo, with one plate, illustrating a paper by C. F. Gissler on Coleopterous larvæ of the family *Tenebrionidæ*, which appears to be carefully worked out and likely to prove of value, and the figures (chiefly concerning the pygidia and antennæ) seem to be well drawn. The other papers are on the genus *Colias*, *Samia cynthia*, and on some species of *Thecla*. The number of

American serials exclusively devoted to entomology is constantly increasing.

A SLIGHT earthquake was felt between 9.15 and 9.30 P.M., April 24, at Sigmaringen. The direction was not observed. The following particulars have reached the *Times* of the earthquake which occurred in Persia on March 22, at 3.42 A.M. (London time, 12.37 A.M.). It lasted 12s., was felt at Tauris and east as far as Zendjan; no damage was caused in Tauris, but in the vicinity of Mianeh, where the shocks continued with more or less vigour up to April 2, great damage and loss of life have occurred. An official report, prepared for the Persian Government by the Persian Telegraph authorities at Mianeh gives the damage, as far as is at present known, as follows:—21 villages totally destroyed, 54 greatly damaged, 922 persons killed, together with 2,660 sheep, 1,125 oxen, 124 horses, and 55 camels. The centre of the disturbances was the mountain of Bousgonche.

WE learn from the *Colonies and India* that an American explorer has recently discovered in the little-known district of Yucatan, bordering on British Honduras, a valuable insect, possessing properties which ought to make it a rival of the cochineal and shellac-producing insects. This is the *neen*, or *niin*, a species of *Coccus*, which feeds on the mango tree and similar plants, and exists in enormous quantities in Central America. It is of considerable size, of a yellowish brown colour, and emits a peculiar oily odour, containing as it does, a large quantity of fatty oil, or rather grease. This grease is used by the natives for various purposes, being highly prized as a medicinal oil for external application, and it is also employed for mixing paints. It can be made to change its condition very considerably by different processes. When exposed to great heat, the lighter oils evaporate, leaving a tough flexible mass, resembling half-softened wax, but unaffected by heat or cold, which may be used as a lacquer or varnish. When burnt, this material produces a thick semi-fluid mass, somewhat resembling a solution of india-rubber, which after a few days becomes hard and solid. As a cement this substance will be invaluable, and it might also be used for waterproofing purposes.

WITHIN a few days the scientific committee for the organisation of the Paris Exhibition of Applied Sciences will hold an important meeting. The exhibition will be open from July to November.

SEVERAL of the Conseils Généraux of the surrounding departments have voted funds for the erection of an observatory on the top of Mont Ventoux, in Vaucluse. It will be the third high meteorological station in France, and very likely not the last. M. Ferry, the Minister of Public Instruction, is favourable to the erection.

"THE Silk-Worm, being a brief Manual of Instruction for the Production of Silk," is the title of a pamphlet by Mr. C. V. Riley, professor of the U.S. Department of Agriculture. Silk-worm rearing seems likely to become an important industry in some parts of the United States.

THE March number of the *Journal* of the Statistical Society contains the concluding part, upwards of 180 pages, of Mr. C. Walford's elaborate and valuable paper on the Famines of the World. The whole paper, we believe, will be published separately.

MESSRS. HEYWOOD, of Manchester, have just published the tenth series of Science Lectures for the People delivered in that city. The volume, which can be had for a few pence, contains nine lectures by some of the most eminent men of science of the day. Huxley lectures on William Harvey, Roscoe on the Sun, Flower on the Tasmanians, Williamson on Insectivorous Plants, Barrett on Edison and his Inventions, Dawkins on Our Earliest Ancestors in Britain, Abel on the Modern History of Gunpowder, Dallinger on the Minutest Forms of Life, and Romanes on Animal Intelligence. Several of the lectures are illustrated.

MR. RICHARD RATHBUN has reprinted from the *Proceedings* of the Boston Society of Natural History, a pamphlet of 25 pages on the Devonian brachiopoda of the Province of Para, Brazil. The list is a long one, and many species are described for the first time.

IT will be difficult to surpass or even equal our American friends in the illustrated scientific works which they have begun to publish in such quantity. We have had occasion to mention more than one work of this class recently, and now we receive the first part of "Characeæ Americanæ," illustrated, described and published by Dr. T. F. Allen, of New York. The particular specimen described, and illustrated by an exquisitely coloured plate, is *Chara gymnopus*, A. Br., var. *elegans*, A. Br.

WE have on our table the following works:—"Our New Protectorate," 2 vols., J. C. McCoan (Chapman and Hall); Karl von Gebler's "Galileo Galilei," translated by M. Sturge (Kegan Paul and Co.); "The Encyclopædia Britannica," vol. ix. (A. and C. Black); "Geography" (School Books for South Africa, No. 1), Dr. John Shaw (W. Collins); "Elements of Natural Philosophy," Part i., Second Edition, Thomson and Tait (Printed at Cambridge University Press); "Chemistry of Common Life," J. F. W. Johnson and A. H. Church (Blackwood and Co.); "Shadows of the Coming Truth" (Elliot Stock); "Caves of South Devon and their Teachings," J. E. Howard (Hardwicke and Bogue); "Scientific Results of the Second Yarkand Mission;" 6 Plates, from the Notes of Ferdinand Stoliczka (Quaritch); "End-on Illumination in Private Spectroscopy," Piazzi Smyth (Neil and Son, Edinburgh); C. Peschel's "Geschichte der Erdkunde," Parts i. and ii., Edited by Prof. Dr. Sophus Ruge (R. Oldenburgh, München); "Pre-Historic Times," fourth edition, Sir John Lubbock, Bart. (F. Norgate); "Dictionary for Architects," No. 1, W. J. Christy (Griffith and Farren); "Reduction of Greenwich Meteorological Observations" (Spottiswoode); "The Flowers of the Sky," R. A. Proctor (Strahan); "On Certain Effects of Starvation on Vegetable and Animal Tissues" (D. D. Cunningham, Government Printer, Calcutta); "The Microscopic Organisms found in the Blood of Man and Animals" (Government Printer, Calcutta); "Rambles in North-Western America," J. M. Murphy (Chapman and Hall); "Atlas of Histology, Parts 1 and 2, E. Klein and N. Smith (Smith Hall); "How to learn Danish," E. C. Otté (Trübner and Co.); "Key to How to Learn Danish," E. C Otté (Trübner and Co.); "Anatomy and Physiology of Man," G. G. P. Bale (Remington and Co.); "On Artificial Manures," by M. Georges Ville, translated and edited by William Crookes (Longmans); "Agricultural Ants of Texas," H. C. McCook (Trübner); "De la Ligue Contre les Vivisections, ou la Nouvelle Croisade," Par un Anglais (Ernest Leroux); "L'Eclairage Electrique," Le Comte Th. du Moncel (Hachette); "Contributions to the Anatomy of the Central Nervous System of Vertebrate Animals," Alfred Saunders; "Infection—Diseases in the Army," Prof. R. Virchow (H. K. Lewis); "Recherches sur l'Électricité," Gaston Planté (Paris, A. Fournan); "On the Daily Inequality of the Barometer" (W. W. Rundell); "Freedom in Science and Teaching," Ernst Haeckel (Kegan Paul and Co.).

THE additions to the Zoological Society's Gardens during the past week include a Black-handed Spider Monkey (*Ateles melanochir*) from Central America, presented by Mr. D. R. Comyn; two Prairie Marmots (*Cynomys ludovicianus*) from North America, presented by Mr. W. G. Marshall; a Guilding's Amazon (*Chrysotis guildingi*) from St. Vincent, West Indies, presented by Mr. G. Dundas, C.M.Z.S.; a Cuvier's Podargus (*Podargus cuvieri*) from Australia, presented by Mr. R. S. C. Baber; a Lesser Long-eared Bat (*Plecotus brevimanus*), British Isles, presented by Mr. J. Ward; a three-toed Amphiuma (*Amphiuma means*) from North America, presented by Mr. A. C. Cole; a Bonnet Monkey (*Macacus radiatus*) from India, an Egyptian Cat (*Felis chaus*) from North Africa, a Common Ass (*Asinus vulgaris*) from Persia, a Grey-headed Porphyris (*Porphyris poliocephalus*) from South Asia, a Puff Adder (*Vipera arietans*) from the Cape of Good Hope, deposited.

RECENT CONTRIBUTIONS TO THE HISTORY OF DETONATING AGENTS[1]

AMONG the many explosive preparations which have during the last thirty years been proposed as substitutes for gunpowder, on account of greater violence and other special merits claimed for them, not one has yet competed with it successfully as a propelling agent, nor even as a safe and sufficiently reliable explosive agent for use in shells; for industrial applications and for very important military or naval uses, dependent upon the destructive effects of explosives, it has had, however, to give place, to a very important extent, and in some instances altogether, to preparations of gun-cotton and nitro-glycerine.

But there appeared little prospect that either gun-cotton or nitro-glycerine, whether used in their most simple condition or in the forms of various preparations, would assume positions of practical importance as explosive agents of reliable, and therefore uniformly efficient, character, until the system of developing their explosive force through the agency of a detonation, instead of through the simple agency of heat, was elaborated.

Before the first step in this important advance in the application of explosive agents was made by Alfred Nobel, about twelve years ago, the very variable behaviour of such substances as gun-cotton and nitro-glycerine, when exposed to the heat necessary for their ignition under comparatively slight modifications of attendant conditions (*e.g.* as regards the completeness and strength of confinement or the position of the source of heat with reference to the main mass of the material to be exploded) rendered them uncertain in their action, and at any rate, only applicable under circumstances which confined their usefulness within narrow limits. The employment by Nobel of an initiative detonation, produced by the ignition of small quantities of mercuric fulminate or other powerful detonating substances, strongly confined, for developing the violent explosion, or detonation, of nitro-glycerine, opened a new field for the study of explosive substances, and the first practical fruit was the successful application of plastic preparations of nitro-glycerine and of compact forms of compressed gun-cotton, with simplicity and certainty, to the production of destructive effects much more considerable than could be accomplished through the agency of much larger amounts of gunpowder, applied under the most favourable conditions. Whereas very strong confinement has been essential for the complete explosion of these substances, so long as the only known means of bringing about their explosion consisted simply of the application of fire or sufficient heat, no confinement whatever is needed for the development, with certainty, of a decidedly more violent explosive action than they are capable of exerting when thus applied, if they are detonated by submitting some portion of the mass to the blow or concussion developed by a sharp detonation, such as is produced by the ignition of a small quantity of strongly confined mercuric fulminate.

The conditions essential to the development of detonation in masses of nitro-glycerine and gun-cotton, or preparations of them, and the relations to and behaviour towards each other of these and other explosive bodies, in their character or functions as detonating agents, have been made the subject of study by the lecturer during the last ten years, and some of the earlier results published by him in connection with this subject also led to the pursuit of experimental inquiries of analogous character by Champion and Pellet and others.

Some of the chief results attained by Mr. Abel's experiments may be briefly summarized.

It was found that the susceptibility to detonation, as distinguished from explosion, through the agency of an initiative detonation, is not confined to gun-cotton, nitro-glycerine, and preparations containing those substances, but that it is shared, though in very different degrees, by all explosive compounds and mixtures.

It was demonstrated that the detonation of nitro-glycerine and other bodies, through the agency of an initiative detonation, is not ascribable simply to the direct operation of the heat developed by the chemical changes of the charge of detonating material, and that the remarkable property possessed by the sudden explosion of small quantities of certain bodies (the mercuric and silver fulminates) to accomplish the detonation of nitro-glycerine and gun-cotton, is accounted for satisfactorily by the mechanical force thus suddenly brought to bear upon some part of the mass operated upon. Most generally, therefore, the degree of facility with which the detonation of a substance will develop similar change in a neighbouring explosive substance, may be regarded as proportionate to the amount of force developed *within the shortest period of time* by that detonation, the latter being in fact analogous in its operation to that of a blow from a hammer or of the impact of a projectile.

Thus, explosive substances which are inferior to mercuric fulminate in the suddenness, and the consequent momentary violence of their detonation, cannot be relied upon to effect the detonation of gun-cotton, even when used in comparatively considerable quantities. Percussion cap composition, for example, which is a mixture of fulminate with potassium chlorate, and is therefore much less rapid in its action than the pure fulminate, must be used in comparatively large quantities to accomplish the detonation of gun-cotton.

The essential difference between an explosion and what we now distinguish as a detonation lies in the comparative suddenness of the transformation of the solid or liquid explosive substance into gas and vapour.

The gradual nature of the explosion of gunpowder is illustrated, in its extreme, by burning a train of powder in open air; the rapidity and consequent violence of the explosion is increased in proportion to the degree of confinement of the exploding charge, or to the resistance opposed to the escape or expansion of the gases generated upon the first ignition of the confined substance.

In the case of a very much more sensitive and rapidly explosive substance than gunpowder, such as mercuric fulminate, the increase in the rapidity of its transformation, by strong confinement, is so great that the explosion assumes the character of a detonation in regard to suddenness and consequent destructive effect. A still more sensitive and rapidly explosive material (such as the silver fulminate and iodide of nitrogen) produces when exploded in open air effects akin to those of detonation; yet even with these bodies, confinement operates in increasing the rapidity of the explosive to suddenness, and consequently in developing a more purely detonative action.

Detonation, developed in some portion of a mass, is transmitted with a velocity approaching instantaneousness throughout any quantity, and even if the material is laid out in the open air in long trains composed of small masses. The velocity with which detonation travels along trains thirty or forty feet in length, composed of distinct masses of gun-cotton and of dynamite, has been found to range from 17,000 to 24,000 feet per second. Even when trains of these explosive agents were laid out with intervening spaces of half an inch between the individual masses composing the trains, detonation was still transmitted along the separated masses with great though diminished velocity.

The suddenness with which detonation takes place has been applied as a very simple means of breaking up shells into small fragments and scattering these with considerable violence, with employment of very small charges of explosive agent. Thus by filling a 16-pr. common shell completely with water and inserting a charge of ½ oz. of gun-cotton fitted to a detonating fuze, the shell being thoroughly closed by means of a screw plug, the force developed by the detonation of the small charge of gun-

[1] Weekly Evening Lecture at the Royal Institution, Friday, March 21, 1879. By Professor Abel, C.B., F.R.S. Revised by the Author.

cotton is transmitted instantaneously in all directions by the water, and the shell is thus broken up into a number of fragments averaging fourteen times the number produced by bursting a shell of the same size by means of the full amount of powder which it will contain (13 oz.). Employing 1 oz. of powder, in place of ½ oz. of gun-cotton, in the shell filled with water, the comparatively very gradual explosion of the powder charge is rendered evident by the result; the shell being broken up into less than twenty fragments by the shock produced by the first ignition of the charge, transmitted by the water. In this case the shell is broken up by the minimum amount of force necessary for the purpose, before the explosive force of the powder charge is properly developed. Extensive comparative experiments carried on not long since by the Royal Artillery at Okehampton, demonstrated that this simple expedient of filling common shells with water and attaching a small charge of gun-cotton with its detonator to the fuse usually employed, allowed of their application as efficient substitutes for the comparatively complicated and costly shrapnel and segment shells.

Another illustration of the sharpness of action developed by detonation as compared with explosion, consequent upon the almost instantaneous character of the metamorphosis which the explosive agent undergoes in the case of detonation, is afforded by a method which the lecturer applied some years since for comparing the violence of action of charges of gun-cotton and of dynamite arranged in different ways. The charges (5 lb.) to be detonated were freely suspended over the centres of plates of very soft steel of the best quality, which rested upon the flat face of a massive block, or anvil, of iron, having a large central circular cavity. The distance between the upper surface of the plate and the charge suspended over it, was 4 feet. The sharp blow delivered upon the plate by the air suddenly projected against it by the force of the detonation when the charge was fired, forced the metal down into the cavity of the anvil, producing cup-shaped indentations, the dimensions of which afforded means of comparing the violence of the detonation. A much larger charge of powder exploded in actual contact with the plate, would produce no alteration of form in the metal, and the same negative result would be furnished by the explosion over the plate of a heap of loose gun-cotton of the same or greater weight than the charges detonated. The above method of experiment was devised, in the first instance by Mr. Abel, in July 1875, for comparing the quality of some specimens of Llandore steel proposed to be used by the Admiralty for ship-building purposes, with samples of malleable iron, and it has since been employed by Mr. Adamson in carrying out a very useful series of experiments, recently communicated to the Iron and Steel Institute.

It has been stated that detonation can be transmitted from one mass of gun-cotton or dynamite to another through intervening air-spaces. The extent to which such spaces can be introduced without checking detonation is obviously regulated by the size of the masses of explosive detonated; but the distances of air-space through which the detonation of a moderate quantity of the explosive agent will communicate to similar masses, are very limited, a space of 2 inches being sufficient to prevent the detonation produced by a mass of 8 oz. of gun-cotton, freely exposed, from communicating to contiguous ones. If the dispersion of force is prevented in part, and direction is given to the gases violently projected from the centre of detonation, the power of transmitting detonation to separated masses of explosive is increased to a remarkable degree. This is readily accomplished through the agency of tubes, the charge first detonated being just inserted into one extremity, while that to which the detonation is to be transmitted is inserted into the other; or separate charges may be placed at different distances inside a long tube, with long intervening spaces, the initiative charge being inserted at one end. Thus, the detonation of a 1-oz. disk of gun-cotton in open air will not transmit detonation with *certainty* to other disks placed at a greater distance than half an inch from it; but if it be just inserted into one end of an iron tube 2 feet long and 1·25 inch in diameter, a similar disk, inserted into the other extremity of the tube, will invariably be detonated. In tubes of the same kind, of very considerable length, 2-oz. disks of gun-cotton placed at intervals of 2 feet, were detonated through the initiative detonation of one such disk inserted into one extremity of the tube. The results obtained with equal quantities of gun-cotton varied with the diameter, strength, and nature of the material of the tubes used. Dynamite and mercuric fulminate, applied to their own detonation, furnished results quite analogous to those obtained with gun-cotton; but in applying fulminate to the detonation of gun-cotton through the agency of tubes, some singularly exceptional results were obtained.

Silver fulminate was employed for the purpose of instituting more precise experiments than could be made in operating on a larger scale, with gun-cotton, on the influence of the material composing the tubes, of the condition of their inner surfaces, and of other variable circumstances, upon the transmission of detonation. Half a grain of silver fulminate freely exposed and ignited by a heated body, will transmit detonation to some of the compound placed at a distance of 3 inches from it, but does not do so with certainty through a distance of 4 inches. But when the quantity of the fulminate is just inserted into one end of a stout glass tube 0·5 inch in diameter, and 3 feet long, its detonation is invariably induced by that of a similar quantity of the fulminate placed just inside the other extremity of the tube. Glass tubes were found to transmit the detonation of silver fulminate much more rapidly than tubes of several other materials of the same diameter and thickness of substance. Thus, with the employment of double the quantity of fulminate required to transmit the detonation with certainty through a glass tube of the kind described, 3 feet in length, it was only possible to obtain a similar result through a pewter tube 31·5 inches long, a brass tube 23·7 inches long, an indiarubber tube 15·8 inches long, and a paper tube 11·8 inches long. The difference in the results obtained was not ascribable to a difference in the escape of force on the instant of detonation, in consequence of the fracture of the tube, nor to the expenditure of force in work done upon the tube at the seat of detonation. The transmission of detonation appeared also not to be favoured by the sonorosity or the pitch of the tube employed, as the sonorous brass tube was not found to favour the transmission to the same extent as the pewter tube. These differences appeared on further investigation not to be ascribable, to any important extent, if at all, to the difference in the nature of the material composing the tubes, but to be simply, or at any rate almost entirely, due to differences in the condition of the inner surfaces of the tubes. Thus, brass tubes, the inner surfaces of which were highly polished, and paper tubes, when coated inside with highly glazed paper, transmitted the detonation of the silver fulminate to about the same distance as the glass tubes; on the other hand, when the inner surfaces of the latter were slightly roughened by coating them with a film of fine powder, such as French chalk, they no longer transmitted detonation to anything like the distance which they did when the inner surfaces were in the normally smooth condition. Other very slight obstacles to the unimpeded passage of the gas wave through the tubes were found greatly to reduce the facility with which detonation could be transmitted by means of tubes; thus, when a diaphragm of thin bibulous paper was inserted into the glass tube about half-way between the two extremities, detonation was not transmitted, even with the employment of about six times the quantity of fulminate that gave the result with certainty under ordinary conditions.

Among several other interesting results furnished by an examination into the conditions governing and results attending the transmission of detonation by tubes, a remarkable want of reciprocity was found to exist between mercuric fulminate and gun-cotton. The latter substance is more susceptible to the detonative power of mercuric fulminate than of any other substance. The quantity of fulminate required to detonate gun-cotton is regulated by the degree to which the sharpness of its own detonation is increased by the amount of resistance to rupture offered by the envelope in which the fulminate is confined. From 20 to 30 grains are required if the detonative agent is confined in a thin case of wood, or in several wrappings of paper; but as small a quantity as 2 grains of the fulminate suffices to effect the detonation of compressed gun-cotton, provided the fulminate be confined in a case of stout metal (sheet tin) and be closely surrounded by being tightly imbedded in the mass of gun-cotton. If there be no close contact between the two, the quantity of fulminate must be very considerably increased to ensure the detonation of the gun-cotton, and, in attempting to transmit detonation from mercuric fulminate to gun-cotton by means of tubes, it was found necessary to employ comparatively very large quantities of fulminate in order to accomplish this, even through short lengths of tubes. But when the quantity of fulminate used reaches certain limits, the detonation may be

transmitted from it to gun-cotton through very long lengths of tube. In applying gun-cotton, on the other hand, to accomplish the detonation of mercuric fulminate, it was found that this result could be attained, and through considerable lengths of tube (7 feet and upwards) by means of very much smaller quantities of gun-cotton than is needed of fulminate to induce the detonation of gun-cotton through the corresponding distances.

This want of reciprocity between two detonating agents corresponds to one even more remarkable, which was observed by the lecturer in his earlier investigations on this subject. In the first place it was found that the detonation of ¼ oz. of gun-cotton (the smallest quantity that can be thus applied) induced the simultaneous detonation of nitro-glycerine, inclosed in a vessel of sheet tin and placed at a distance of 1 inch from the gun-cotton; while with ½ oz. of the latter, the same effect was produced with an intervening space of 3 inches between the two substances. But on attempting to apply nitro-glycerine to the detonation of gun-cotton, the quantity of the former, which was detonated in *close contact* with compressed gun-cotton, was gradually increased in the first instance to ¾ oz. and subsequently even to 2 oz. without accomplishing the detonation of the latter, which was simply dispersed in a fine state of division, in all instances but one in a large number of experiments.

The force developed by the detonation of nitro-glycerine was proved to be decidedly greater than that of the fulminate, of which from 2 to 5 grains suffice for developing the detonation of gun-cotton, when it is in close contact with them. The non-susceptibility of gun-cotton to detonation by nitro-glycerine is therefore, it need scarcely be said, not ascribable to any deficiency in mechanical force suddenly applied when the nitro-glycerine is detonated.

(*To be continued.*)

INTELLECT IN BRUTES

FROM several additional letters which we have received on this subject we select the following:—

Mr. Claypole, of Antioch College, Ohio, writes:—A friend of mine is employed on a farm near Toronto, Ontario, where a horse belonging to the wife of the farmer is never required to work, but is allowed to live the life of a gentleman for the following reason: Some years ago the lady abovementioned fell off a plank bridge into a stream where the water was deep. The horse, which was feeding in a field close by, ran to the spot and held her up with his teeth till assistance arrived, thus probably saving her life. Was this reason or instinct? Again, a gentleman engaged in the business of distilling at Cincinnati has more than once told me that the rats in his distillery are in the habit of drinking any spirits spilt on the ground or left in open vessels, and that they often become, in consequence, so tipsy that they cannot run, and are easily taken by hand. Which is this?

Mr. J. J. Furniss, of New York, writes:—Since the publication of my letter (NATURE, vol. xix. p. 385) on the evidence of reasoning power in an elephant, afforded by the fact that he thatched his back with grass when exposed to the heat of the sun, I have received additional data bearing on the subject from Mr. W. A. Conklin, the superintendent of the Central Park Menagerie. I am informed by him that he has frequently observed elephants, when out of doors in the hot sunshine, thatch their backs with hay or grass; that they do so to a certain extent when under cover in the summer time, and when the flies which then attack the animals, often so fiercely as to draw blood, are particularly numerous; but that they never attempt to thatch their backs in the winter. This seems to prove that they act intelligently, and for the attainment of a definite end. It would be interesting to learn whether elephants in their wild state are in the habit of so thatching their backs. It seems more probable to suppose that in their native wilds they would avail themselves of the natural shade afforded by the jungle, and that the habit is one which has been developed in consequence of their changed surroundings in captivity. I am also informed by Mr. Conklin that when taken to the water in summer the elephants first sprinkle their bodies all over with water, and then quench their thirst. They never so sprinkle themselves in cold weather. Their reasoning in this case seems to be, "I cool my mouth by pouring water into it, now if I pour water over my back it will cool that also." Am I not justified in calling this "abstract" reasoning?

Mr. Charles Stewart, of Tighnduin by Killin, Perthshire, sends the following story:—A few years ago I kept a collie dog named "Bodach" at my farm, for herding the milk cows, and who recognised the dairy-maid as his mistress. On her directing him to keep the cows on a certain part of a field, he would lay himself down in the centre of a line fixed by him as the proper limit. Patiently and vigilantly he would remain in quietness until any of the cows passed his limit, when he would swoop down on the trespasser, take her by the heels, and drive her back. It was wonderful in how short a time the cows came to recognise and respect the arrangement. He also came to know some of the cows by name. One of them named "Aggi" required at certain seasons to be milked oftener than the others, and the dairymaid had only to say in Gaelic "Bodach, go and bring home Aggi," when he would start for the pasture, single out Aggi, and bring her carefully home.

O. J. H. sends the following:—An ordinary domestic cat was equally fond of a friend of mine and of myself. As a test, we resolved to try the following experiment. We each held a piece of bread, of the same size, shape, &c., above the eyes of the animal. He looked at each hand and its contents alternately, attempting to solve the problem of getting at the bread without exhibiting partiality for either of his friends. He at last seemed to decide upon an expedient, for, raising himself upon his hind legs, he simultaneously seized a piece of bread in each of his front paws, and conveyed the food thus obtained to his mouth. On repeating the experiment after a lapse of some time, no difficulty was experienced in dealing with the matter, as the expedient just mentioned was resorted to without a moment's hesitation.

Prof. Nipher, of Washington University, St. Louis, U.S., writes:—A friend of mine living at Iowa City, had a mule, whose ingenuity in getting into mischief was more than ordinarily remarkable. This animal had a great liking for the company of an oat-bin, and lost no opportunity, when the yard gate and barn-door were open, to secure a mouthful of oats. Finally the mule was found in the barn in the morning, and for a long time it was impossible to discover how he had come there. This went on for some time, until the animal was "caught in the act." It was found that he had learned how to open the gate, reaching over the fence to lift the latch, and that he then effectually mystified his masters, by turning round, and backing against it, until it was latched. He then proceeded to the barn-door, and pulling out the pin which held the door, it swung open of its own accord. From the intelligence which this animal displayed on many occasions, I am of the opinion that had not discovery of his trick prevented, it would soon have occurred to him to retrace his steps before daylight, in order to avoid the clubbing which the stable boys gave him in the morning. It may be added that this animal had enjoyed no unusual educational advantages, and his owners found it to their interest to discourage his intellectual efforts as much as possible.

The Rev. George Henslow endeavours to sum up as follows from the stories that have already appeared:—I am quite ready to admit that more than one instance (notably Dr. Frost's cat, which spread crumbs to catch birds, and which is paralleled by one mentioned in Wood's "Natural History," which "chirped" like a sparrow, and so enticed and caught them), if correctly stated, and *if the motive* of the animals could in every case be proved, will completely overthrow my supposition that animals never copy us with the same or a rational purpose. I cannot help thinking, however, that such cases are very rare. Moreover, I will abandon my notion of abstract reasoning, at least, as hitherto described, for I now think that what I meant by the want of the faculty would be better described as an impotence, or, at least, a feebleness of mind in concatenating correlative ideas; or, perhaps, a want of a receptivity of the suggestiveness of things will express my meaning. On the other hand, I still see no reason for believing that animals can conceive of a purely abstract idea. Thus, "V. I." says a mule would turn on a tap, but did not turn it off again. The reason I would suggest is that *wastefulness* being an abstract conception, the mule could not entertain it. If this be correct, we may now proceed a step further. The idea of a personal *Ego* is purely abstract; hence I am led to believe that no animals can be *self-conscious*, and as a direct consequence, they cannot be either moral or immoral, but are simply automata and non-moral. Like children, they can learn by being scolded, when they displease their master, so that a conscience similar to a child's can be produced in them;

yet they cannot naturally be moral. Thus, *e.g.*, self-interest is all in all with animals, but it can never lapse into selfishness, which is the *conscious* abuse of self-interest. We "punish" a dog, but we never look upon it as a criminal. So, too, no animal can ever act unjustly towards another, because it cannot be conscious either of justice or injustice. The abstract conceptions of righteousness and justice are only applicable to acts done *under a sense of righteousness and justice.* The same remark applies to personal immoralities; so that no animal can be immoral. That animals cannot entertain abstract ideas is not at all surprising, seeing how slow children are to do the same. A somewhat grotesque illustration will show this. A class of boys was asked what conscience was. None could explain it, so the teacher defined it as "something within you that tells you when you have done wrong." A boy at once exclaimed it was a stomach-ache. On inquiry it turned out that he had stolen and eaten some unripe fruit, and doubtless felt the *remorse* of conscience accordingly! If, then, my former position be qualified, I would restate it as corrected by the cases recorded as follows:—Animals reason as we do, but always in connection with concrete phenomena whether immediately apprehended by the senses, or present to consciousness through memory; but like children they are slow to perceive the suggestiveness of things. They have, morever, no power of conceiving truly abstract ideas. Hence they cannot be self-conscious, cannot conceive of God, and can neither be moral nor immoral, but are simply non-moral automata. On the other hand, that which rescues man from being an automaton pure and simple, is his power of conceiving of abstract ideas, which enables him to be self-conscious; consequently he can conceive of a personal, *i.e.* self-conscious Deity, so that he at once becomes a responsible being, and can be positively moral or immoral.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

At a recent meeting of the governors of Owens College, Manchester, the Committee on the proposed University charter presented a report. It appears that "negotiations have been actively carried on with the Council of the Yorkshire College, Leeds, partly by letter and partly by means of interviews between members of the respective committees. The suggestions agreed to by the Council of the Yorkshire College, Leeds, provide that the Owens College shall be named in the charter establishing the University as the first college in it; that the president and the principal of the Owens College shall be the first chancellor and vice-chancellor of the new University; that its *locus* shall be Manchester; and that in the system of proportionate representation proposed for the governing and the executive bodies of the University, the Owens College shall in either case begin with the maximum number of representatives allowed by the scheme." To obviate objection to a local name, that of Victoria University is suggested. The report and draft memorial were approved of, and the Committee were requested to make arrangements for the presentation of the memorial to the Lord President of the Privy Council at as early a date as possible, and for carrying out the other suggestions of the report, which was passed.

The British Medical Association are getting up a memorial to the House of Commons urging the immediate institution at Oxford of a thorough medical curriculum, on the same basis as the medical schools of other English towns, in the following subjects at least:—Human anatomy, physiology of man, general pathology, materia medica, clinical medicine and surgery for beginners, State medicine, including jurisprudence and public health.

SCIENTIFIC SERIALS

American Journal of Science and Arts, April.—An opening obituary notice of the distinguished botanist, Dr. Jacob Bigelow, who died in January, aged 92, is here followed by a note in which Prof. Marsh traces the connection between the two widely divergent forms of vertebræ of the toothed birds *Ichthyornis* and *Hesperornis.* In the former the articulation of the centrum is cup-shaped; in the latter the ends of the centrum are saddle-shaped, as in ordinary birds. The third cervical vertebra of Ichthyornis, however, has a transition form, affording a ready solution of the development of the modern avian vertebra from the fish-like. The order of development of vertebræ seems this: Biconcave vertebræ (fishes and amphibians), plane vertebræ (mammals), cup-and-ball vertebræ (reptiles), saddle vertebræ (birds).—The double stars discovered by Mr. Alvan G. Clark, which (except Sirius) have not been brought to the attention of astronomers generally, are the subject of a paper by Mr. Burnham.—Interesting details are furnished by Prof. Church of underground temperatures in the Comstock lode in Nevada, where are, apparently, the hottest mines in the world. (The rock in the lower levels seems to have a pretty uniform temperature of 130° F.)—Prof. Lesquereux contributes a review of Count Saporta's valuable work on the plants of the world before man, taking occasion to compare the essential characters of certain tertiary groups of the North American continent, in order to determine some points still under discussion as to their age.—Mr. Palsinger indicates a method of estimating the thickness of Young's reversing layer; and among other subjects dealt with are, the lower jaw of Loxolophodon and the presence of chlorine in scapolites.

Journal of the Franklin Institute, April.—We note here the following:—Reports of the Committee on Science and the Arts, on Ainsworth's automatic switch for railroads, and a machine for treating flax, hemp, &c.—Tests of a Baldwin locomotive, by Mr. Hill.—The Franklin Institute standard screw thread.—The Butler mine fire cut off, by Mr. Drinker. In the course of investigations described in this last paper, Mr. Drinker thought it established that coal *in situ cannot* be burned *en masse*, but that the walls of carbonaceous slaty rock inclosing solid coal *can* be burned or calcined *in situ.* The mining engineers who discussed his paper seemed generally to be of opinion that the slates in the old fire were not actually burned, but that the carbonaceous matter in them was rather subjected to a process of distillation.

The *Jornal de Sciencias mathematicas physicas e naturaes* (No. xxiv., December, 1878) contains the following papers:—On the oblique projection of a circle, by L. P. da Motta Pegado.—Contributiones ad floram mycologicam lusitanicam, by F. de Thuemen.—Ornithological notes, by J. V. Barboza du Bocage.—On the birds of the Portuguese possessions in West Africa (continuation), by the same.—On electrical condensation and the condensing force, by A. A. de Pina Vidal.—On a new densimeter, by Virgilio Machado.

The quarterly *Revue des Sciences naturelles* (tome vii. No. 4) contains the following original papers:—Morphological researches on the family of *Gramineæ*, by D. A. Gordon.—Note on the genital organs and the propagation of some *Limacidæ*, by S. Jourdain.—Observations on the destruction and the development of the ovigerous capsule of *Blatta orientalis*, by G. Duchamp.—Catalogue of the land and river molluscs of the Hérault department, by E. Dubrneil (continuation).—Note on the soil of Montpellier, by P. de Rouville.—Note on the Pyrenees of the Aude, by M. Leymerie.

SOCIETIES AND ACADEMIES

London

Royal Society, March 6.—"On the Characters of the Pelvis in the Mammalia, and the Conclusions respecting the Origin of Mammals which may be based on them." By Prof. Huxley, Sec. R.S., Professor of Natural History in the Royal School of Mines.

In the course of the following observations upon the typical characters and the modifications of the pelvis in the mammalia, it will be convenient to refer to certain straight lines, which may be drawn through anatomically definable regions of the pelvis, as *axes.* Of these I shall term a longitudinal line traversing the centre of the sacral vertebræ, the *sacral axis;* a second, drawn along the ilium, dorso-ventrally, through the middle of the sacral articulation and the centre of the acetabulum, will be termed the *iliac axis;* a third, passing through the junctions of the pubis and ischium above and below the obturator foramen, will be the *obturator axis;* while a fourth, traversing the union of the ilium, in front with the pubis, and behind with the ischium, will be the *iliopectineal axis.*

The least modified form of mammalian pelvis is to be seen, as might be expected, in the Monotremes, but there is a great difference between *Ornithorhynchus* and *Echidna* in this respect, the former being much less characteristically mammalian than the latter.

The distinctive features of the mammalian pelvis have been

clearly indicated by Gegenbaur,[1] who points out that in mammals, in contradistinction from reptiles, "the longitudinal axis of the ilium gradually acquires an oblique direction, from in front and above, backwards and downwards. The part which represents the crista above thus becomes turned forwards, or more or less outwards, with increase of lateral surface, the acetabular part backwards and downwards; hence the ischium retains its original direction in the produced long axis of the ilium, and, at the same time, takes up a position in relation to the vertebral column similar to that which obtains in birds. The conditions of this position are, however, to be sought in factors of a totally different nature in mammals from those which produce it in birds; for, in the former, the ischium follows the changed direction of the ilium, whilst in birds the ilium has nothing to do with the matter, and the ventral elements of the pelvis appear to pass towards the caudal region, independently of the ilium."

On one point, however, I cannot agree with Gegenbaur's conclusions. He is of opinion that the ilium of mammals answers to the post-acetabular part of the ilium of birds, and that "the *crista ossis ilii* of mammals corresponds with the posterior edge of the post-acetabular part of the bird's ilium. Between the two parts, therefore, there is the difference of a rotation through an angle of almost 180°." On the contrary, it appears to me evident that the whole *crista ilii* in a mammal corresponds with the whole dorsal edge of the ilium in a bird or a reptile, and that the angle through which the iliac axis rotates amounts to not more than 90°. I cannot reconcile the contrary view either with the relations of the ilium to the sacrum, or with the attachment of the muscles.

On comparing the pelvis of *Ornithorhynchus* with that of a lizard, or that of a chelonian, it will be observed that the resemblance between the former and the sauropsidan pelvis is, in most respects, closer than that which it bears to the higher mammalian pelvis. In the reptiles both the pubes and the ischia unite in a ventral symphysis; the pubis has a strong pectineal process, which acquires very large dimensions in the *Chelonia;* the metischial processes are also often very strong. Nevertheless, there is an important difference, for in all these animals the iliac axis is either nearly perpendicular to the sacral axis, or slopes from above downwards and forwards; the obturator axis also inclines downwards and forwards. Hence in most *Lacertilia* and *Chelonia*, the pubes slope forwards very obliquely, while the ischia come more and more forwards.

In other words, such modifications of the pelvis as occur in the Lacertilia and the Chelonia are of an opposite kind to those which take place in mammalia.

The same thing is true of the *Crocodilia*.

Thus it appears to be useless to attempt to seek among any known Sauropsida for the kind of pelvis which analogy leads us to expect among those vertebrated animals which immediately preceded the lowest known mammalia. For, if we prolong the series of observed modifications of the pelvis in this group backwards, the "pro-mammalia" antecedent to the Monotremes may be expected to have the iliac and obturator axis perpendicular to the sacral axis, and the iliopectineal axis parallel with it; something, in short, between the pelvis of an *Ornithorhynchus* and that of a land-tortoise; and provided, like the former, with large epipubes intermediate in character between those of the lower mammals and those of crocodiles. In fact, we are led to the construction of a common type of pelvis, whence all the modifications known to occur in the Sauropsida and in the mammalia may have diverged.

It is a well-known peculiarity of the urodele amphibia, that each *os innominatum* consists of a continuous cartilage, the ventral half of which is perforated by a foramen for the obturator nerve, but has no large fibrous fontanelle or obturator foramen in the ordinary sense of the word. As the junction of the dorsal with the ventral moiety, the acetabulum marks off the iliac portion of the pelvic arch above, from the pubic and ischial regions below; and these are further distinguishable, even apart from their ossifications, by the position of the foramen for the obturator nerve and the origins of the muscles. In full-grown specimens of *Salamandra maculosa* the pelvis presents the following characters:—The iliac axis is slightly inclined forwards, while the iliopectineal axis is practically parallel with the sacral axis. The iliac ossification extends into the acetabulum, and forms a triangular segment of its roof with the apex downwards, exactly as in lizards. The posterior and inferior side of the triangle is separated by a thin band of the primitive cartilage from the upper edge of the similarly triangular cotyloid end of the ischial ossification, the anterior edge of which is vertical again as in lizards. Between this edge and the anterior and inferior edge of the iliac ossification there is a cartilaginous interspace, as in crocodiles, which represents the cotyloid end of the pubis. This cartilaginous part of the pubis gives rise to a pectineal process, which has the same position as in birds and in *Ornithorhynchus*. In the floor of the acetabulum the pubic ossification makes its appearance as a very thin lamina, which extends, underneath the pectineal process, inwards; and gradually surrounds the whole of the thickened transverse ridge of cartilage which corresponds with the pubis. The pubis is thus represented by an axis of cartilage surrounded by bone, and the thick inner extremities of the two pubes are largely united by fibrous tissue. The ischia are relatively large, and are united, partly by cartilage and partly by ligament, in a long symphysis. Their posterior and external angles are produced into short metischial processes. In one specimen I observed a distinct sutural line between the anterior curved edge of the right ischium and the corresponding pubis, while no such suture could be traced upon the other side.

The pelvic arch of *Salamandra*, therefore, contains all the elements which are found in the higher vertebrata, but the obturator fontanelle is wanting, and it seems to me that in such a pelvis we have an adequate representation of the type from which all the different modifications which we find in the higher vertebrata may have taken their origin.

In the lizards and the *Chelonia* the iliac and obturator axes have inclined forwards, and the epipubes have been reduced to such rudiments, as have been described in chameleons and in some tortoises.[1]

In the crocodiles, with the same general pelvic characters, the cotyloid end of the pubis retains its imperfectly ossified condition, while the epipubes represent the vastly enlarged rami of the salamandrine epipubis.

In the Ornithoscelida and in birds, the ilia elongate, but it is the modification of the pubes and ischia which is the most characteristic feature of the pelvis, and the epipubis vanishes.

In the Pterosauria and in the Dicynodonts, the salamandrine non-development of an obturator fontanelle persists; and, in the former, the sessile rami of the epipubis appear to be represented by the so-called marsupial bones.

Unless the like should prove to be the case in the Dicynodonts, it is in the mammalia alone that the subsacral portion of the ilium elongates backwards, carrying with it the pubis and the ischium, between which a large rounded obturator fontanelle is developed.

These facts appear to me to point to the conclusion that the mammalia have been connected with the amphibia by some unknown pro-mammalian group, and not by any of the known forms of Sauropsida; and there is other evidence which tends in the same direction.

Thus, the amphibia are the only air-breathing vertebrata which, like mammals, have a dicondylian skull. It is only in them that the articular element of the mandibular arch remains cartilaginous; while the quadrate ossification is small, and the squamosal extends down over it to the osseous elements of the mandible; thus affording an easy transition to the mammalian condition of these parts.

The pectoral arch of the Monotremes is as much amphibian as it is sauropsidan; the carpus and the tarsus of all Sauropsida, except the Chelonia, are modified away from the urodele type, while those of the mammal are directly reducible to it; and it is perhaps worth notice, that the calcar of the frogs is, in some respects, comparable with the spur of the Monotremes.

Finally, the fact that in all Sauropsida it is a right aortic arch which is the main conduit of arterial blood leaving the heart, while, in mammals it is a left aortic arch which performs this office, is a great stumbling-block in the way of the derivation of the mammalia from any of the Sauropsida. But if we suppose the earliest forms of both the mammalia and the Sauropsida to have had a common amphibian origin, there is no difficulty in the supposition that, from the first, it was a left aortic arch in the one series, and the corresponding right aortic arch in the other, which became the predominant feeder of the arterial system.

The discovery of the intermediate links between reptilia and

[1] "Beiträge zur Kenntniss des Beckens der Vögel," *Jenaische Zeitschrift* vi.

[1] Hoffman, "Beiträge zur Kenntniss des Beckens der Amphibien und Reptilien," *Nied. Archiv für Zoologie*, 1876.

aves, among extinct forms of life, gives every ground for hoping that, before long, the transition between the lowest mammalia at present known and the simpler vertebrata may be similarly traced. The preceding remarks are intended to direct attention to the indications of the characters of these pro-mammalian vertebrata, which the evidence at present forthcoming seems to me to suggest.

In the relatively large size of the brain, and in the absence of teeth, the only existing representatives of the Ornithodelphia present characters which suggest that they are much modified members of the group. On comparing the brain of *Echidna*, for example, with that of many marsupialia and insectivora, its relative magnitude is remarkable: and, in view of the evidence which is now accumulating, that the brain increases in size in the later members of the same series of mammalia, one may surmise that *Echidna* is the last term of a series of smaller-brained Ornithodelphia. Among the higher vertebrata I think that there is strong reason to believe that edentalous animals are always modifications of toothed forms.

Institution of Civil Engineers, April 22.—Mr. Bateman, president, in the chair.—The paper read was on dioptric apparatus in light-houses for the electric light, by Mr. James T. Chance, Assoc. Inst. C.E.

PARIS

Academy of Sciences, April 24.—M. Daubrée in the chair.—The following papers were read:—On the condition of the roadstead of Port Said, by M. De Lesseps. The bottom appears to have reached a state of equilibrium, and the dredging operations carried out annually will suffice to maintain this state. The sand deposits, opposed by dredging, are chiefly formed to the north and north-east of the large jetty, in a region reaching about 800 to 1,000 metres from its base. Beyond this, as also to the west, the deposits are more muddy, and are carried away by the action of the sea. M. De Lesseps also spoke hopefully of the Congress to meet on May 15, for determining the best course for an inter-oceanic canal (which he thinks will be achieved before the close of this century).—Complementary researches on the products of distillation of alcohols, by MM. Pierre and Puchot. The authors reproduced synthetically most of the phenomena observed, by operating on aldehydes.—On the navisphere, a nautical instrument, by M. De Magnac. This gives, without calculation, and in a few seconds, the names of the stars that are above the horizon at a given moment; also very approximately, the altitudes and azimuths of these stars; also the angle of route for going from one point to another by the arc of a great circle, and the distance between these points. The instrument has been tried on the steamship *Washington* with excellent results.—Experimental researches on the metallic grains of sporadosideric meteorites, by M. Meunier. The grains are essentially angular and branching, and do not seem to have passed through fusion. They often form envelopes round stony elements of cosmic rock. The Greenland masses of native iron (whose grains are of this character) cannot be thought the product of reduction of the dolerite by the lignite through which they have been erupted. M. Meunier considers them brought from a great depth with ordinary basalt, in which they had been embedded.—On the artificial production of bioxide of manganese, by M. Gorgeu. Artificial bioxide, having all the properties of polianite and pyrolusite, was got by heating, gently and long, at a temperature of 155° to 162°, nitrate of manganese in a glass phial placed in a bath of oil or paraffin. Other methods were tried without success. The authors are of opinion that, in formation of polianite and pyrolusite, the iron suspended in the very fluid mass of fused nitrate of manganese was decanted before decomposition of the nitrate occurred; and the same with all other powdery products mixed with the nitrate.—On tritungstates, by M. Lefort.—On the methodic employment of coloured glasses in achromatopsy, by M. Coursserant. May not the exclusive excitation of certain nerve elements of the retina cause to be produced and accumulated, in certain elements in repose, a quantity of work which will manifest itself in the form of variously coloured light, when these rested elements, solicited in turn, come into action?—Observations of Jupiter's satellites, at the Toulouse Observatory in 1878, by M. Baillaud.—Formation of a function, $F(x)$, possessing the property $F[\phi(x)] = F(x)$, by M. Appel.—Letter to M. Dumas on the apparatus of Lavoisier, by M. Truchot. The Conservatoire des Arts et Métiers contains about a dozen of Lavoisier's instruments, chiefly relating to synthesis of water and calorimetry. But this is not all that remains; his chemical laboratory and physical cabinet have been piously preserved by his family. They are now in possession of M. de Chazelles, at Canière, near Aigue-perse (Puy de Dôme), and M. Truchot has made an inventory of them, which he here gives briefly. Many of the instruments are of great interest.—Chemical function of anhydrous acetic acid, by M. Loir. It presents the general properties characterising aldehydes.—On nitrosoguanidine, by M. Jousselin. He indicates a method of obtaining it in considerable quantities, and describes several of its reactions.—On the value of certain chemical agents employed in dyeing with aniline black, by M. Witz. The proved inertia of chromium in mixtures with chlorates contrasts singularly with the marvellous energy of vanadium, the industrial use of which presents the greatest economical advantages.—On the formation of hail, by M. Oltromare. Suppose the temperature of a considerable cloudy mass (formed by cooling and condensation of saturated air and electricity keeping the molecules apart) to go down to − 14°, implying a state of *surfusion*,—and the electricity of the mass suppressed by discharge, the molecules then clashing together will be changed into pieces of ice more or less coherent.—On the amyloid appearance of cellulose in champignons, by M. de Seynes.—On the mode of formation of biliary canaliculi in hepatitis, and the consecutive production of tubulated glands in the liver of the rabbit, by MM. Nicati and Richaud.—M. Jaubert claimed priority with regard to the MM. Henry's new catadioptric telescope. M. Faye pointed out, however, that MM. Henry did not seek to modify the optical power of reflectors by addition of a large refracting lens, but simply to close the tube so as to suppress movements of the interior air.—M. Larry presented the catalogue of the South Kensington Loan Collection (third edition), accompanied with a French Guide.

VIENNA

Imperial Academy of Sciences, March 6.—The following among other papers were read:—On the new recurrence of halotrichite and melanterite at Idria, by Prof. Zepharovich.—On the electrical perforation of glass, by Prof. Waltenhofen.—On the decomposition of formiate of ammonium at a high temperature, by Herr Andreasch.—On determination of the co-efficient of internal friction in viscous liquids by gravitation experiments, by Herr Schröttner.—On direct introduction of carboxyl groups into phenols and aromatic acids, by Prof. Senhofer and Dr. Brunner.—On facts of experience lying at the base of mechanics, by Herr Heller.—Muscular system of the extremities of the orang, by Prof. Langer.—On lacunar consumption of striped muscular fibres, by Prof. Klemmsiewicz.—Eruptive rocks of the western Balkans, by Prof. Niedzwiedzki.—Theory of the metallic thermometer, by Herr Jüllig.

March 13.—Remarks on the telephone, by Prof. Boltzmann.—On a new substance, nitroso-sulphhydantoin, by Prof. Naly and Herr Andreasch.—On resorcin-sulpho-acids, by Herr Fischer.

CONTENTS

THURSDAY, MAY 8, 1879

THE CHEMISTRY OF COMMON LIFE

The Chemistry of Common Life. By the late James F. W. Johnston, M.A., F.R.S., Professor of Chemistry in the University of Durham. A new edition, revised and brought down to the present time. By Arthur Herbert Church, M.A. (Blackwood and Sons, Edinburgh and London, 1879.)

IT is now a great many years since the writer of the present review first read the work which as edited by Prof. Church he wishes to introduce to the readers of NATURE. He has not forgotten the keen interest and pleasure which the book awakened in him as a boy, and which were re-awakened when a few weeks ago the new volume came into his hands. Though times have changed since this book was published—now twenty-five years ago—though we are now almost deluged with scientific manuals and primers, intended to gratify the growing taste for science, or rather, perhaps, to meet the needs of our quasi-Chinese examination systems, yet such books as Johnston's "Chemistry of Common Life," or the equally charming companion work, "The Physiology of Common Life," by the late G. H. Lewes, have not been superseded. Full of facts which it is often difficult to find elsewhere, written in a style which will charm the most fastidious, awakening at every step the reader's desire to know more of the subject which is treated of, these two works have always appeared to us very models of popular scientific writing.

To edit such a work as "The Chemistry of Common Life" so as to bring the book up to date without departing from the author's plan or awakening unpleasant comparisons, was by no means an easy task, and one which could only be discharged adequately by an easy writer, thoroughly conversant with chemistry, and not unfamiliar with physiology; the task has, we think, been admirably performed by Mr. Church, and we recommend the volume which he has edited as one eminently deserving of the study of the medical man and the student of physiology.

The first chapter treats of "The Air we Breathe." In it we find discussed the composition of the atmosphere, the mode of preparation, and properties of its constituent gases; the importance of the watery vapour of the air, the formation of rain and dew, and their many uses; the accidental constituents of the air. The second chapter is devoted to "The Water we Drink." Here we find discussed the properties of hydrogen, the differences between a chemical compound and a mechanical mixture, the powers of water as a solvent, the quantities of mineral matter in some river, lake, spring, and sea waters; the causes of the hardness of waters, the organic impurities of water, the solubility of gases in water, and the importance of the presence of oxygen in water in relation to the life of fishes, besides many other topics which cannot be enumerated.

As an example of the way in which interesting information is brought together and ingenious suggestions advanced, which are sure to arouse an inquiring spirit in the reader, we quote the following very characteristic discussion of the influence exerted by certain vegetable matters upon the organic matters of water, with an ingenious explanation of the mystery of the waters of Marah:—

"Well-waters sometimes contain vegetable substances also of a peculiar kind, which render them unwholesome, even over large tracts of country. In sundry districts the decaying vegetable matters of the surface soil are observed to sink down and form an ochreous *pan*, or thin yellow layer, in the sub-soil, which is impervious to water, and through which, therefore, the rains cannot pass. Being arrested by this pan, the rain-water, while it rests upon it, dissolves a certain portion of the vegetable matter, and when collected into wells, is often dark-coloured, marshy in taste and smell, and unwholesome to drink. When boiled, the organic matter coagulates, and when the water cools, separates in blocks, leaving the water wholesome and nearly free from taste or smell. The same purification takes place when the water is filtered through charcoal, or when *chips of oak wood are put into it.* These properties of being coagulated by boiling, and by the tannin of oak wood, show that the organic matter contained in the water is of an albuminous character, or resembles white of egg. As it coagulates, it not only falls itself, but it carries other impurities along with it, and thus purifies the water—in the same way as the white of egg clarifies wines and other liquors to which it is added.

"Such is the character of the waters in common use in the *Landes* of the Gironde around Bordeaux,[1] and in many other sandy districts. The waters of rivers and of marshy and swampy places often contain a similar coagulable substance. Hence the waters of the Seine at Paris are clarified by introducing a morsel of alum, and the river and marshy waters of India by the use of the nuts of the *Strychnos potatorum* of which travellers often carry a supply. One of these nuts, rubbed to powder on the side of the earthen vessel into which the water is to be poured, soon causes the impurities to subside. In Egypt the muddy water of the Nile is clarified by rubbing bitter almonds on the sides of the water-vessel in the same way.

"In these instances the clarification results from the iron compounds or the albuminous matter being coagulated by what is added to the water, and in coagulating, it embraces the other impurities of the water, and carries them down along with it. Salt, and many saline matters, have likewise the power of clearing many kinds of thick and muddy water. So long as the water contains but little dissolved matter, all its particles of mud remain a long time suspended. But the addition of almost any soluble salt, even in small proportion, will, as it were, curdle the impurities, causing them to collect together and to settle.

"These cases, and especially that of the sandy Landes of Bordeaux, and elsewhere, throw an interesting light upon the history of the waters of Marah, as given in the fifteenth chapter of Exodus—

"'So Moses brought Israel from the Red Sea, and they went out into the wilderness of Shur; and they went three days in the wilderness, and found no water. And when they came to Marah, they could not drink of the waters of Marah, for they were bitter: therefore the name of it was called Marah. And the people murmured against Moses, saying, What shall we drink? And he cried unto the Lord, and the Lord showed him a *tree*, which when he had cast into the waters, the waters were made sweet.'"[2]

The chapter on Water is followed by others which treat of "The Soil we Cultivate and the Plants we Rear," of "The Bread we Eat" and "The Beef we Cook." Under the heading of "The Beverages we Infuse" we find separate chapters allotted to "The Teas," "The Coffees," "The

[1] Fauré—*Annales de Chim. et de Phys.*, Septembre, 1853, p. 84.
[2] Exodus, xv. 22–25.

Cocoas," the natural history, the various modes of preparation, the chemical composition, the physiological action, and the dietetic uses being in each case satisfactorily and pretty fully discussed.

"The Sweets we Extract" have several chapters devoted to them, in which the chemistry of the sugars is treated of, and the various methods of preparing cane, maple, beet-root, and even manna and milk-sugar are fully described.

"The Liquors we Ferment" include "The Beers," "The Wines," and "The Brandies." Under each head we find an amount of general information relating to modes of manufacture, to chemical composition, and to habits of various nations, which is truly remarkable.

"The Narcotics we Indulge in" have eight chapters devoted to them, the subjects treated of being the following:—tobacco; the hop and its substitutes; the poppy and the lettuce; Indian hemp; the betel nut and the pepperworts; coca; the Siberian fungus, and the minor narcotics. Then follow "The Odours we Enjoy," "The Smells we Dislike," and "The Colours we Admire." The last-named chapter is entirely new, and we shall therefore notice it at somewhat greater length than its predecessors.

It appears to us rather a mistake to have classed the blood colouring matter under the heading of "The Colours we Admire;" beautiful though the colour of blood may appear to be to the physiologist, we doubt very much whether most persons would not object to the statement implied in the classification adopted. As the proximate principle which confers upon the coloured blood corpuscles their remarkable function as the oxygen-carriers of the body, it ought in our opinion to have been relegated to the chapter which treats of "What we Breathe and Breathe for." In connection with hæmoglobin, though not in the chapter now under discussion, we find one of the really few inaccurate statements with which we have to charge Mr. Church. "But if the carbon-containing substances derived from man's food are burnt throughout his body, and if this burning takes place because of oxygen brought from the lungs, how and in what forms, may we ask, are the products of this burning, being no longer of use, conveyed out of the body? The very hæmaglobin which has brought the oxygen carries away the chief product of the burning—namely, carbonic acid gas." This is not correct.

Hæmoglobin possesses no special power of absorbing carbon dioxide, and the greater part of this body as it is formed, is taken up by the liquor sanguinis in which it is held partly in a state of solution and partly of feeble chemical combination. We observe that Prof. Church applies to the blood colouring matter the term hæm*a*globin instead of hæm*o*globin. The second is the now universally adopted way of spelling the word; it is a barbarously coined word and can only be preferred to the etymologically more correct hæmato-globulin on the score of use and wont; the change made by Mr. Church is, however, surely no improvement, as it is the stem (*αἱματ-*) and not the nominative case (*αἷμα*) which should be incorporated in the compound word. In the words "hæmorrhage," "hæmorrhoidal," "hæmoptysis," we have at least the sanction of old usage given to the coiners of "hæm*o*globin."

After shortly describing hæmoglobin Mr. Church refers to Turacin, a very remarkable red colouring matter containing 8 per cent. of copper, which he discovered several years ago in the pinion feathers of the *Plantain-eaters.* "The existence of an animal pigment so rich in copper as turacin, offers many interesting problems for study. Traces of this metal seem generally diffused in most vegetables and many animals; but here are more than traces—weighable and visible quantities." The sheets of the book had probably passed through the press before the announcement of Dr. Frederique's recent discoveries had been made in reference to the blood of the octopus, which would otherwise have probably been noticed. Dr. Frederique, of Ghent, in the first place confirmed the observations made by previous writers as to the colour of the blood of the octopus; in this creature the arterial blood is blue, whilst the venous blood is colourless. On agitating the venous blood with oxygen or atmospheric air it becomes blue; conversely on treating the blue arterial blood with reducing agents or heating it in the vacuum of a mercurial pump it loses its blue colour. The colour is found by Frederique to be due to a complex body containing copper, to which he has given the name hæmocyanin, which appears to have an analogous constitution to hæmoglobin; like this body it is decomposed easily and yields a proteid body and a colouring matter which contains all the copper of the original substance. This copper containing proximate principle is dissolved in the plasma and is undoubtedly the oxygen carrier of the blood of the octopus.

The chapter on "The Colours we Admire" closes with a succinct account of the synthesis (by Graebe and Liebermann) of alizarin, the madder pigment, and by a notice of recent researches on the constitution of certain of the coal-tar colours.

Did space permit we should notice the concluding chapters, of which some are mainly devoted to certain physiological topics, others to a recapitulation on "The Circulation of Matter." We trust, however, that the sketch which we have given will suffice to give some idea of the wide scope and deep interest which attaches to Mr. Church's admirable edition of "The Chemistry of Common Life." A. G.

SILURIAN FOSSILS

A Monograph of the Silurian Fossils of the Girvan District in Ayrshire, with Special Reference to those contained in the "Gray Collection." By H. Alleyne Nicholson, M.D., D.Sc., F.R.S.E., Professor of Natural History in the University of St. Andrews, and Robert Etheridge, Jun., F.G.S., Acting-Palæontologist to the Geological Survey of Scotland. Fasciculus I. *Rhizopoda, Actinozoa, Trilobita.* Pp. 135, Pl. i.-ix. (Blackwood and Co., 1878.)

THE authors of this monograph state in their preface that they have been enabled to undertake their task through the aid rendered to them by a grant from the Government fund administered by the Royal Society, and we cannot but feel in examining this first instalment of the result of their labour that the pecuniary assistance has been in this case exceedingly well bestowed.

The Silurian district of Girvan in Ayrshire is one that has attracted much attention from geologists, and considerable difference of opinion has existed as to the exact correlation of the several members of the formation as there exhibited with the equivalent English deposits. The fossils, though numerous, are often in a rather unsatisfactory condition as regards preservation, and it was most desirable that a careful study of all the known forms should be made by competent palæontologists. The richly stocked cabinets of Mrs. Robert Gray have furnished the larger part of the specimens described, and the completion of this first part of the work was rendered possible by the liberality of Mr. Gray.

The memoir commences with an account of the bibliography of the subject, which appears to be very full and complete, and then proceeds to the description of the lower forms of life. Any one who will take the trouble to compare the lists given by our authors with those previously published cannot but be struck by the large additions which are now made to the Girvan Silurian fauna. A single doubtful fucoid and four species of *Foraminifera* are described as occurring in the Girvan rocks, and among the latter is the remarkable *Saccammina carteri*, which is so excessively abundant in some of the Carboniferous limestones. This form has been recognised as identical with the Carboniferous type by Mr. H. B. Brady himself, and its existence in Silurian strata adds another example—one of great interest to geologists—of the wide range in time of some of the lower forms of life.

Among the corals from the Girvan area Messrs. Nicholson and Etheridge enumerate no less than twenty-two forms, some being old and well-known species, but the majority are new to science; indeed several new genera of Actinozoa are established in the present work. The specimens are usually in a bad state of preservation, a difficulty which has been to some extent overcome by the authors by the employment of thin sections. The fact which comes out most strikingly from the study of the Cœlenterate fauna of the Girvan beds is that the nearest analogues of the Silurian fossils of Scotland are to be found not in the English area but in the American. The same fact, it will be remembered, was made very strikingly manifest from Mr. Salter's studies of the fauna of the Silurian limestone of Durness in Sutherland.

Of Trilobites twenty-eight species are now described as occurring in the Girvan district, and among them several forms new to science have been detected.

As the present volume only contains the first part of the results of our author's labours we do not find a full discussion of the bearing of the palæontological evidence on the interesting question of the age of the several Girvan deposits. There can be no doubt, however, that both the Upper and Lower Silurian are there represented, though the exact correlation of the different members of the series can only be successfully attempted when the fossils have been more fully worked out.

The present fasciculus is illustrated by nine very well executed lithographic plates from the pencil of Mr. Charles Berjean. We congratulate the authors on the able manner in which they have executed this first portion of their task, and hope soon to have to record the appearance of other portions of this important monograph.

OUR BOOK SHELF

Natural History Rambles. The Sea-Shore. By Prof. P. M. Duncan, F.R.S. *Lane and Field.* By the Rev. J. G. Wood. *Underground.* By J. E. Taylor, F.L.S. *The Woodlands.* By M. C. Cooke, LL.D. (London: S.P.C.K., 1879).

THESE four handy little volumes are well put together, and seem to us decidedly superior to works of a similar kind with which we used to be familiar in our youth. The evident purpose of the volumes is not to teach their subjects systematically, but to lead those into whose hands they may fall to take an interest in the common objects of nature which may be met with in an occasional walk. For this purpose they seem to us well adapted, and the information they convey on the whole trustworthy. They abound in suitable and well-executed illustrations, and might appropriately be put into the hands of any one, old and young, whose circumstances would give him a chance of using them.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Brorsen's Comet

LAST night, May 3, I observed Brorsen's comet pass nearly centrally over the star DM, + 61°, No. 873. In the principal focus of the telescope were two straight bars, 43″ (seconds of arc) wide intersecting in the centre of the field. The bars are at right angles to one another, and were inclined 45° to the hour circle. With this arrangement it was easy, by moving the telescope gently about the polar axis (which is well adjusted), to determine the conjunctions in R.A. and in declination, while angles of position coinciding with the bars, and distances in parts of the breadth of a bar, could be estimated with considerable accuracy. In this manner I made the following observations of the position of the comet with reference to the star:—

Chronometer time. h. m. s.	Angle of position. °	Dist. ″	
10 2 59	260	33	Distance measured by beats of chronometer.
10 4 31	270	12	Ditto.
10 6 20	—	—	Star apparently central in comet.
10 7 30	320	10	Star a little right of centre.
10 11 30	0	—	Estimated conjunction in R.A.
10 16 0	45	16	
10 18 15	45	43	
10 20 30	45	65	

Projecting these observations on a chart of ruled squares, it appears that at 10h. 11m. 36s. (corresponding to 10h. 11m. 14s. G.M.T.) the comet followed the star 0·68s. in R.A. and was 12″ N. of it, while the nearest approach of the centre of the comet to the star was 7″ at about 10h. 7m.

The moon was shining with great brilliancy (being nearly full) and made the comet faint, reducing its apparent diameter to 1½ or 2 minutes. The star is given in the DM as of the 8·8 magnitude, but I think is underrated a little. While the comet was passing over it there was no sensible diminution of its lustre. The DM position of the star for 1855·0 is—

$$\alpha = 6h.\ 7m.\ 25s.,\ \delta = +\ 61°\ 28'·9.$$

The light of the comet has diminished rapidly since April 4. It is now less bright than a 9th mag. star.

Blackheath G. L. TUPMAN

IT is to be hoped that while the comet remains with us the observations of Prof. Young (NATURE, vol. xix. p. 559), and of Mr. Christie (NATURE, vol. xx. p. 5) may be repeated and confirmed by those who possess telescopes of sufficient power.

May I trespass upon your space so far as to ask Mr. Christie to explain a little more clearly what the precise carbon bands are with which the bands in the comet-spectrum are coincident. He speaks of the less-refrangible edge of the brightest comet band coinciding with the corresponding edge of the green carbon-band at 5200—in the spectrum of an alcohol vacuum-tube—and then proceeds to remark that the bands in the spectrum of alcohol are identical with those in the spectrum of olefiant gas and of carbon-dioxide and carbon-monoxide. If we are to understand that all the gases are inclosed in vacuum-tubes, then it must be remembered that the spectrum they give is the second spectrum of carbon in which the brightest bands have the wave-lengths 5610·5, 5198·4, 4834, and 4505. But it appears from Prof. Young's comparison of the comet spectrum with the blue flame of a Bunsen burner, that the brighter band agrees with that of the first spectrum of carbon whose wave-length is 5165·5 within about the interval of the *b* lines

$$(b_1 - b_4 = 5183·0 - 5166·7 = 16·3).$$

The spectrum with which Huggins compared the spectrum of Comet II. 1868, and of Coggia's comet in 1874, was obtained by taking the spark in olefiant gas at the ordinary pressure, and is therefore again the first spectrum of carbon.

The following comparison will exhibit the uncertainty which I wish to have explained :—

Position of least refrangible Edges of Bands.			
Brorsen's comet	5600	5200	—
Carbon spectrum I.	5634·7	5165·3	4739·8
Carbon spectrum II.	5610·5	5198·4	4834

May I suggest the following comparison : to bring up the occulting bar from the blue end of the spectrum till it just covers the brightest comet band, then to introduce into the telescope first the light from a Bunsen burner or blowpipe flame, and then that from a vacuum tube inclosing carbonic oxide.

If the comet spectrum is that of Carbon I., light will be seen in the second case, but none in the first ; if it be that of Carbon II., no light will be seen in either case.

Giggleswick, May 5 WILLIAM MARSHALL WATTS

I CAN fully confirm Young's observation that the spectrum of Brorsen's comet is not now the same as that observed by Huggins in 1868, as figured in Roscoe's "Spectrum Analysis," p. 251. On the 28th and 30th I observed the spectrum with a Browning's "miniature spectroscope" on a 4½-inch refractor, and compared it with the carbon spectrum of a low gas flame, and found the three usual bands of the latter to coincide with the three bands of the comet as completely as my instruments would show. It was needful to use a wide slit. T. W. BACKHOUSE

Sunderland, May 6

Temperature Equilibrium in the Universe in Relation to the Kinetic Theory

I AM inclined to think I shall best answer Mr. W. Muir's letter by not disputing the vague charges of unsoundness he has brought against me, but in endeavouring to make more clear the position for which I contend.

The object of my paper (NATURE, vol. xix. p. 460) was to contest the necessity of supposing that existing physical principles must have been violated in past time. I sought to prove that there was no reality in this necessity, by showing that even from our present imperfect knowledge, an explanation for the existing state of things might be evolved consistent with principles which at present prevail. Perhaps I may do well to add a few words in order to elucidate a point which was not too clearly expressed.

For mere sake of illustration, let us imagine a spherical envelope which permits neither change of volume nor passage of heat, to inclose a space of diameter, say 10^{10} times the distance between the sun and Sirius. First, let all the matter within this space be at the zero of temperature. Second, let all the matter within our envelope be at such a temperature that it is entirely dissociated into discrete molecules. Between these two extremes there is room for any number of mean states in which matter might be more or less aggregated, or discrete, and my point was that the universe might actually be in one of these intermediate states. It should be scarcely necessary to observe that we have limited our space merely for the sake of fixing our ideas. All that we require is gained, if, instead of using the impermeable envelope, we surround our sphere with infinite space filled with matter in a similar condition to that which the sphere inclosed. It is important to note that the volumes must be taken large enough to form a fair sample of the general state of the universe. Prof. Clerk Maxwell has shown ("Theory of Heat," p. 328) that a demon existing inside a gas might find irregularity where to us giants all appears uniform. With respect to the universe, may we not be in the position of demons?

London, April 29 S. TOLVER PRESTON

Barometric Pressure and Sun-Spots

IN his letter to NATURE, vol. xviii. p. 567, on "Sun-Spots and Weather," Mr. Fred. Chambers has shown that the curve of mean barometric pressure at Bombay throughout the year varies with the inverted sun-spot curve. Taking this fact together with the commonly-received idea that the annual variation of barometric pressure in Central Asia is due to the corresponding annual variation of solar radiation, he thence concludes that "the sun is hottest about the time that the spots are at a maximum, and coldest about the time when they are at a minimum." Now, even if the validity of the logical process by which "secular" is substituted for "annual" in this argument be admitted to hold in a general way, have we any reason to suppose that the atmospheric conditions at Bombay, a marine station on a peninsula, can be adequately taken to represent those which prevail in the centre of the Asiatic continent, or that they approximate to the latter to any greater extent, or even as much as those at St. Petersburg, for example?

On the other hand, if conditions which presumably reach their maximum intensity in the centre of the continent are so distinctly marked at such a distance from it as Bombay, they should at least be visible to some extent at St. Petersburg, which is certainly more continental in position, if not actually nearer the centre of the continent than the former city.

Such being the case, I should be glad to know how Mr. Chambers would account for the following remarkable fact, viz., that the mean annual barometric pressures at St. Petersburg from 1822 to 1871 show a well-defined relation to the sun-spots *precisely the reverse* of that evinced by the figures for Bombay.

I might, if I had followed Mr. Chambers's example, have concluded, with as good grounds for my opinion, that "the sun is coldest when most spotted," and *vice versa*, but I prefer to wait until more extensive investigations have given us a sounder basis for induction than at present exists. Meanwhile, I place before your readers the figures on which my statement regarding the St. Petersburg pressures is based. The employment of a variety of methods of comparison has invariably given the same results.

In the following table the variations from the mean, expressed in millimetres, are compared with the sun-spots according to the plan recommended by Mr. Meldrum, and which for some purposes is superior to those generally adopted hitherto. For brevity's sake only the final columns are given :—

Mean Cycles

	Max. years in 5th line.		Min. years in 7th line.	
	Pressure variation in mm. (1822–71).	Sun-spots (1821–77).	Pressure variation in mm. (1822–71).	Sun-spots (1816–72).
1.	−0·52	−33·9	+0·15	+23·3
2.	−0·35	−23·4	+0·59	+14·5
3.	−0·48	0·0	+0·78	+ 4·8
4.	−0·24	+28·2	+0·63	− 5·6
5.	+0·44	+43·1	+0·29	−19·0
6.	+0·70	+34·2	−0·31	−32·5
7.	+0·80	+16·8	−0·83	−37·1
8.	+0·62	+ 0·2	−0·71	−25·4
9.	+0·34	−14·2	−0·40	+ 1·8
10.	−0·07	−24·2	−0·14	+30·9
11.	−0·88	−26·3	+0·23	+44·8

It will be noticed that the pressure epochs lag behind the sun-spot epochs in the same way as the air-temperature epochs determined by Dr. Köppen.

The figures for the pressure are taken from the Annals of the Central Observatory. The above relation was first brought to my notice by my friend, Mr. S. A. Hill, of Allahabad.

Mr. Chambers's notion that "if the winter rainfall of Northern India is really due to the cold of winter, we should expect it to be greatest when the sun is coldest" is partly

answered by the fact that, according to Mr. Hill, the epochs of heaviest winter rain are approximately those of *highest* mean annual temperature. E. DOUGLAS ARCHIBALD

Distribution of the Black Rat

MR. MIDDLETON'S letter in NATURE, vol. xix. p. 460, induced me to inquire whether the black rat still occurs in Dresden, the museum under my care possessing several specimens, which were procured on the spot several years ago. The streets where this rat then occurred being known to me, viz., Meissener-strasse, Alaun-gasse, Königsbrücker-strasse, all on the right bank of the Elbe, in Dresden-Neustadt, I inquired in many houses, offering a relatively high reward for a specimen, but hitherto in vain. The museum possessing further a specimen from a place called the Schenkhübel, about an hour's walk from the town, in the direction of the last of the above-named streets, I had traps put there, but also in vain; only the brown rat, *Mus decumanus*, could be procured.

Every two years a general rat poisoning being ordered by the magistrate of the town, I shall wait till the next one (March, 1880), and then try to state whether *Mus rattus* still lives in Dresden, as it no doubt lived here several years ago.

The museum possesses besides specimens from Mühlhausen, in Thuringia, and a series from Saxe-Altenburg; in the latter country I do not know the exact locality, the man—a dealer—who sent them, being very mysterious on this point, but I have indubitable evidence that it still lives there, and even is not rare on some spots. Knowing that it occurred some time ago in the brewery of Blankenhain Castle, near Crimmitzschau, in Saxony, I inquired there, but got the answer that for two years it has been replaced by *M. decumanus.*

Therefore, I am not sure that *M. rattus* still lives in the kingdom of Saxony, but I *am* sure that it occurs in the Saxon Duchies. I shall publish the results of my further inquiries in case they are successful.

From the Malay Archipelago I brought *M. decumanus*, but not *M. rattus*. I got specimens from North and South Celebes, besides other localities, but as the *Mures* in my collections are not yet definitely determined, I cannot give more particulars now. A. B. MEYER

Royal Zoological Museum, Dresden, May 3

Mice and Beetles

PERMIT me to ask, through the medium of your columns, if it is known whether mice kill the common kitchen black-beetle. I have been unable to find anything bearing upon this subject, but having observed that there is an apparent reduction in the number of beetles, or at least no increase in number while the mice are permitted to live, and also that the mice do not touch any articles of food in the kitchen, where they are somewhat numerous, I have been led to think that they prey on the beetles in some way. W. WORBY BEAUMONT

The Cause of Thunder

I HAVE lately seen it stated in a text-book upon electricity and magnetism that the phenomenon of thunder is not fully accounted for by any theory as yet brought forward. Whether this be so or not I am not sufficiently acquainted with the subject to say. I believe the commonly accepted theory is that a vacuum is created in the path of the electric spark and that the subsequent in-rush of the air produces the detonation. If, however, it be allowed that the electric spark is not a material substance, but merely a natural force or mode of motion, the possibility of this theory is at once disposed of.

It is a well-known fact that the passage of electricity in a high state of tension, through a mixture of oxygen and hydrogen, not only causes an explosion, but also causes the formation of water, and it seems to me that, given the existence of free oxygen and hydrogen in the region of the electric disturbance, the phenomenon of thunder is sufficiently accounted for.

Whether the normal amount of hydrogen in the air is sufficient to cause the stupendous noise of thunder I am not competent to judge, but if not I would suggest that the presence of an abnormal amount might be accounted for by the process of the electrolysis, which would probably occur between the two poles of the thunder-cloud before the tension became so great as to cause a rupture of the circuit and consequent discharge of the electric spark. I would also draw your attention to the fact that every thunder-clap is immediately followed by an increase in the quantity of water deposited in the shape of rain. Does not this point to the formation of water by the explosion of the gases?

As I myself am unable both from want of means and time to investigate the matter, I should be glad to find that someone better qualified had taken the subject in hand. It is a frequent experiment of Dr. Tyndall's to show his audience real clouds; I feel convinced that by following this line of inquiry he could give us a real thunderstorm. S. A. R.

The April Meteors

ON the night of the 20th these meteors were watched for between 10h. 45m. and 11h. 30m., after which the stars were obscured by a dense fog. During the ¾h. of observation 15 shooting-stars were counted, of which 4 or 5 only belonged to the shower of *Lyrids*. These were faint and somewhat slow, with slight trains and short paths. The radiant point could not be exactly fixed. Of the other meteors three were brilliant (2 = 1st mag. and 1 = 2nd mag.), and moved with extreme swiftness from a radiant point at $286° + 23°$. They left bright greenish streaks, and were readily distinguished from the *Lyrids*, though the radiants lie near together. This new shower near β Cygni (Albireo) appears to form an important display at this epoch. I saw several bright, rapid meteors from it on April 20–21 last year, and determined the position of its radiant point from a number of shooting-star paths given in Dr. Weiss's two volumes of Austrian observations at $288° + 22°$ (20 meteors) for the period April 19–23 (see *Monthly Notices* R.A.S., vol. xxxviii. p. 396). It is further confirmed by a stationary meteor recorded by Palisa at Troppau on April 19, 1870, at $289°{\cdot}4 + 26°{\cdot}4$, and it will be advisable to look out specially for this prominent shower of swift, streak-leaving meteors during future returns of the *Lyrids*. The latter display has quite failed during the last few years. W. F. DENNING

Ashleydown, Bristol, April 22

Salmo salar and the Schoodic Salmon

UNDER date of March 13, in the course of remarks on a late report of the U.S. Commissioner of Fish and Fisheries, you express a wish for an explanation of the fact that a sea-going salmon (*Salmo salar*) was found among the Schoodic "land-locked" salmon. I take pleasure in supplying the explanation. The fish referred to were taken in Grand Lake Stream, which connects two of the Schoodic lakes, tributary to the St. Croix River, which discharges into an arm of the sea on the border between the United States and Canada. Before the obstruction of the St. Croix by mill-dams, there was nothing to prevent the ascent of the sea-going salmon to this stream, and it is among the traditions of the aborigines that they were formerly often taken here along with the small "land-locked" or fresh-water salmon. The sea-salmon they called Pl-láhm; the land-locked, Tag-e-wáh-nàhn; and though for many years the sea-salmon were almost wholly prevented from ascending the river by the mill-dams, they have not been entirely exterminated, and the upper waters have been rendered in a degree accessible to the remnant by means of fish-ways constructed within a few years.

The specimen taken was, at the close of the season, set free with the other captured fish, and doubtless returned to sea.

I will add that the latest studies of American ichthyologists on the subject have led to the conclusion that the Schoodic and other "land-locked" salmon are specifically identical with *Salmo salar* (*vide* Jordan, "Manual of the Vertebrates of the Northern United States," 1878, p. 357).

Grand Lake Stream, Maine, U.S.A., April 9 — CHAS. G. ATKINS, Asst. to the U.S. Commissioner, Fish and Fisheries

Intellect in Brutes

A FEW months ago I made the acquaintance of a dog, which, I think, is worthy of a place among the dogs, and cats, and rats, and mules that are helping the pages of NATURE to determine the degree and kind of animal intelligence.

"Priest's" is a hotel on the way from the Calaveras Grove of Big-trees to the Yosemite. In former years, on the arrival of the stage, the landlady would send the dog to the poultry yard to catch chickens for the tourists' dinner. Now the dog "takes time by the forelock." The stage is due at six o'clock. About

five o'clock the dog saunters leisurely down the road till he meets the stage, he then bounds back to the poultry-yard, catches chickens, bites their heads off, and takes them to the cook! The number of chickens he kills bears a relation to the number of passengers he saw in the stage.

A gentleman who was stopping at the hotel for a few days went into the woods one afternoon with a gun. When he returned the dog came to him in much excitement to see what game he had taken. Finding his hands and his bag empty the dog ran into the forest and returned in less than an hour with a bird, which he gave with an air of compassion to the unskilful hunter. W. D. GUNNING

Waltham, Mass., April 18

ON THE EVOLUTION OF THE VERTEBRATA[1]

SEVERAL theories of the vertebrate skeleton have been promulgated during the last century, some of which have since been abandoned, and others greatly modified. About a quarter of a century ago, three great stumbling blocks were removed from the study of animal forms, by the discovery that the cell-wall was not essential as inclosing sarcode, by the removal of the old conceptions about the origin of species, and by the rejection of the vertebrate theory of the skull in its older and grosser form. In the present course, the lecturer wishes to give both an analytic and synthetic account of the vertebrate skeleton, to see if a consistent history cannot be given of every cartilage, bone, and joint, in the higher types.

A vertebrated animal is constructed of a chain of segments similar to each other, which are obsolete in the head, and in each of which there is a smaller dorsal tube, through which the continuous neural axis runs, and a larger ventral tube, which contains the digestive organs, heart, and main blood vessels. The neural axis swells into three main vesicles in the head, giving rise to the fore, mid, and hind brain. The skeletal structures are formed on a single median axis, the notochord, which lies directly beneath the neural axis, and which is arrested in the head close behind the fore-brain. The barrier, however, which would stop the growth forwards of the notochord, is not developed when its apex shrinks. By the time the embryo is fairly formed, a fold of the palatal skin has given rise to a sac which opens into the lower and hinder part of the fore-brain. This sac is the pituitary body, the manner of the development of which has been clearly made out by Mr. Balfour, in the sharks and skates, and corroborated by the lecturer in the snake, lizard, and green turtle.

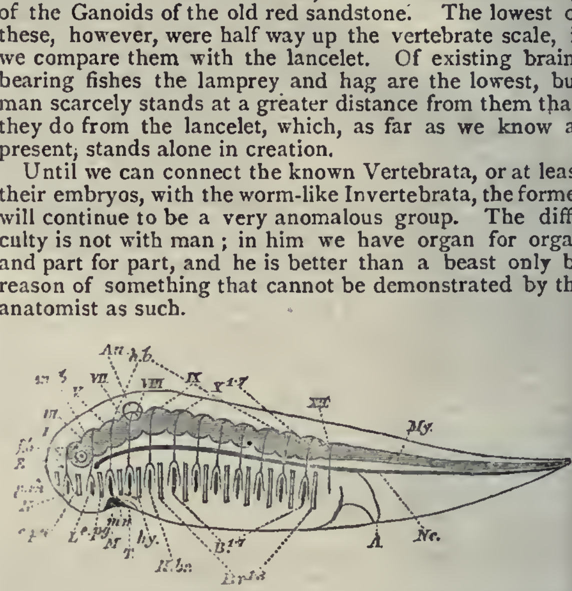
The mouth and posterior aperture do not exist at first, but are formed afterwards as involutions, which, in the latter case, at any rate, are not terminal, the alimentary tract extending behind the anus, and possibly in front of the mouth also in ancient forms. The visceral clefts appear as slits in the wall of the pharynx, and in the aquatic forms, give rise to the gills, while in the higher types (amniota), all of them close up but one, which remains as the tympano-eustachian cavity. The vertebræ alternate with the primary segmental masses. Each centrum, as it chondrifies, constricts the notochord, but there is usually some remnant of it to be seen in the adult in the invertebral spaces. The walls of the head are large and continuous, and its lower arches are generally small, clefts appearing between them. Both the arches and clefts become greatly modified in the adult, especially in the higher types. Thus the upper jaw is probably due to the modification and blending together of two or three pairs of arrested arches.

Besides the axial skeleton, a cartilaginous skeleton is developed immediately under the skin, and thus there is both a cartilaginous exo- and endoskeleton. The exoskeleton gives rise to the labial and extra-branchial cartilages, the limb arches and their limbs, and the intercalary cartilages of the median fins of fishes.

[1] Abstract of Prof. Parker's Hunterian Lectures, delivered at the College of Surgeons, commencing on February 10.

The bony parts of the skeleton are classified according to their relation to the axial or extra-axial cartilaginous skeletons. All bony scales, scutes, or sub-cutaneous bony plates, or tracts, are classified as exoskeletal; ossifications of the endoskeletal cartilage or its perichondrium are, of course, endoskeletal. Unfortunately for science, the extinct lower forms of the Vertebrata had their endoskeletons but slightly ossified, and thus only the outworks of their structure are left to us, as is the case with many of the Ganoids of the old red sandstone. The lowest of these, however, were half way up the vertebrate scale, if we compare them with the lancelet. Of existing brain-bearing fishes the lamprey and hag are the lowest, but man scarcely stands at a greater distance from them than they do from the lancelet, which, as far as we know at present, stands alone in creation.

Until we can connect the known Vertebrata, or at least their embryos, with the worm-like Invertebrata, the former will continue to be a very anomalous group. The difficulty is not with man; in him we have organ for organ and part for part, and he is better than a beast only by reason of something that cannot be demonstrated by the anatomist as such.



A, anus; *Au*, auditory capsule; B^{1-7}, branchial clefts; Br^{1-8}, branchial arches; *E*, eye; *e.pa*, ethmo-palatine; *e.pg*, epi-pterygoid; *f.b*, fore-brain; *h.b*, hind brain; *H.br*, hyo-branchial cleft; *hy*, hyoid arch *L*, lacrymal cleft; *M*, mouth; *m.b*, mid-brain; *mn*, mandible; *My*, myelon; *N*, nostril; *Nc*, notochord; *p.rh*, pro-rhinal; *T*, tympanic cleft. The Roman figures indicate the nerves.

The above diagram represents an ideal vertebrate, the oral, lacrymal, and nasal clefts being taken as homologous with the post-oral clefts. This theory seems probable both from the author's researches on the visceral arches and clefts, and those of Milnes Marshall on the nerves. The seven branches of the vagus (x^{1-7}) are here shown as separate nerves, and the hind brain as a series of enlargements.

As the relation of the endoskeleton to the exoskeleton does not usually seem to be properly understood, it may be as well to say a few more words about it. On the whole the foundations of the internal skeleton are laid in cartilage, and of the external in bone, which is formed by the ossification of fibrous tracts. The cartilage as a rule also ossifies, and this inner or *cartilage* bone has, so to speak, an organic affinity for the outer or *membrane* bone. But there are several things in the vertebrate exoskeleton that are formed of cartilage, as already mentioned; and in the endoskeleton the cartilage is often suppressed in certain parts, bony substance, formed in fibrous tissue, replacing it. Indeed, unossified fibrous tracts often take the place of cartilage. The welding together of parts originally distinct makes the matter much more complicated. No inherited elements are rejected by the morphological force; they are only kept from growing into special tissues until needed. Thus the rich growth of the human brain is covered in with a stout masonry that is merely made up of the inner layer of old ganoid plates, and the cartilages of the human nostril are inheritated from some ancient sucking fish, while the outer ear once figured, speaking morphologically, as the blow-hole of some Silurian shark.

A word or two must now be said about the different kinds of ossification. When the perichondrium, or clothing

of the cartilage, ossifies, it becomes the "ectosteal layer," and is directly related to the cartilage as its ossifying investment; this is a true endoskeletal lamina. Ossification of the dermis gives rise to "dermosteal" (exoskeletal) bony plates, such as the scales and scutes of fishes, and the scutes of reptiles and armadilloes. The intermediate fibrous tissue, especially in the region of the head, ossifies to form the splints, investing bones, or "parostoses" (exoskeletal). Lastly, the cartilage itself undergoes an osseous change, either by central, superficial, or subcentral "endostosis" (endoskeletal).

These species of ossification, like other species, are, however, apt to run into one another.

Fishes.—If we take a survey of the Vertebrata, beginning with the suctorial fishes, viz., the lamprey and hag, we find at first nothing but cartilage forming both the exo- and endoskeleton. The main peculiarities seen in the skeletons of these fishes are the peculiar cartilaginous labials, forming the sucking apparatus, and the basketwork of the "extra-branchials," which embrace the huge multiperforate pharynx. The Selachians (shark, skate, and Chimœra), although retaining much that is low and embryonic in their structure, are in many respects the highest and most reptilian of fishes. Their skeletal growths are uncombined; in their skin are numerous placoid grains or spines, forming the exoskeleton, while in the endoskeleton the first step towards ossification is seen in the calcification of the superficial cells of the cartilage. The labial system is now secondary, a more perfect mouth having taken the place of the sucking-apparatus. The basket-work of the sucking fishes yields bars to strengthen the mouths of the gill-pouches, the gill system being built upon large endoskeletal branchial arches. Limb-girdles, with their paired fins, appear in these fishes.

In the Chondrostei (sturgeon and paddle-fish (*Planirostra*), which are lower kinds of Ganoids, the slightly ossified cartilaginous endoskeleton is supplemented by outer bony plates, which, in the extinct forms, were often covered with an enameled layer. In the head, especially, these plates are conformed to the underlying parts, although they do not combine with them histologically. In this region they have also a constant tendency to a peculiar alternation of paired and unpaired elements. The scutes of the trunk, although suggesting the segments within, do not actually correspond with them.

Here we must look for the exemplars of our own investing-bones (*parostoses*) which are as yet, however, very generalized. The chondroskeleton now gets true ectosteal plates and sheaths, as well as parostoses.

But in those Ganoids that are called Holostei, the endoskeleton rivals that of the ordinary fishes in hardness, and yet the exoskeleton arrives at its highest pitch of perfection. In the head, the dermoskeleton is brought into adaptation to the more important architecture of the inner parts. The most perfect dermoskeleton is seen in the gar-pike (Lepidosteus).

The Dipnoi, which are in many respects related to the generalized chimœroids, show even less mutual adaptation of the outer to the inner skeleton than the sturgeon and paddle-fish, and, moreover, their bony skull plates are, as a rule, feeble, and few in number.

Lepidosiren and Protopterus have a few subcutaneous bones (parostoses) applied to a cranium which is almost entirely devoid of intrinsic ossifications, and scarcely advanced in development beyond that of a Chimœra. But Ceratodus has a helmeted head much like that of the lower Ganoids, the dermal scutes overlying the almost unossified cranium; it has also some sub-cutaneous bones.

The osseous fishes are the highest *as fishes*, but they are least of all related to those types which rise above them in the scale. Their metamorphosis is very great, but the elements are still uncombined. They have a copious growth of sub-cutaneous *bones*, as the Selachians have of sub-cutaneous *cartilages*, while in Ceratodus both are seen in an uncombined condition.

Amphibia.—The Amphibia are a subdivision of the Icthyopsida, which, like the Dipnoi, develop lungs as well as gills, but which often shed the latter, breathing only by the former. Their embryos, like those of fishes, develop neither amnion nor allantois. There are four orders in this sub-class, viz., the Cœcilians, the Urodeles, the Anura, and the Labyrinthodonts, the last of these being the large extinct Amphibia of the coal-measures. The living forms of Amphibia begin life as a sort of fishes, having gills; and, as a rule, they live in the water until they acquire lungs: some keep their gills, and continue to live in the water, while others shed them. The higher kinds undergo so much morphological change, and assume so many new and important characters, that they are perhaps the most instructive of all the Vertebrata.

In the Urodeles and Anura (tail-bearing and tail-less Amphibia) we find many things in common, and many more that are different. While they agree in possessing gills in their larval state, they differ in the character of their gills. The Urodeles have, some for a while, and others throughout life, three pairs of pinnate external gills, attached to the three first branchial arches, a single gill to each arch, there being generally a fourth arch which does not bear a gill. These are true *inner* branchial arches.

Amongst the frogs and toads there are three important modifications of the branchial system. In the common kinds (*Opisthoglossa*) there are at first free tufted gills growing from the two first, at least, of the four branchial arches, all of which are functional. These are soon hidden by an opercular outgrowth from the hyoid arch, which covers over and closes up all the branchial region, leaving, however, a small aperture on the left side. The primary pharyngeal wall not only splits so as to form four clefts on each side, but the wall itself becomes divided so as to form a series of pouches, each of which has a cartilage within and a cartilage without, the opercular skin loosely covering the pouches outside. The intra-branchial arches are small bars; the second and third extra-branchials are large bars, while the first and fourth are large pouches. Tufted vascular (*lophobranchiate*) growths, like those first seen outside, grow on the inside of the large pouches and bars, and also from the three branchial clefts, outside the extra-branchials. These latter correspond with the external gills seen in unhatched sharks and skate.

Dactylethra, one of the two existing *Aglossa*, shows no trace of external gills. The other, tongueless kind, *Pipa*, has probably very temporary rudiments of them. Suctorial cartilages have nearly disappeared in the embryos of Urodeles, but in the Batrachia they are nearly as much developed as in the lamprey. In the Urodeles we find no trace of a gill on the first and second arches behind the mouth, nor on the sixth, which exists in the majority of the species.

It is evident that the tailed Amphibia have been dropping from time to time parts no longer useful to them, whilst straining after a higher organisation. In them we have the beginning of the middle ear; there is a stapes and a fenestra ovalis. Here also a larynx appears for the first time, and the shoulder and hip girdles, and the fore and hind limbs are developed similarly to those of the higher types.

In neither Anura nor Urodeles is it possible to make a sharp distinction between a parostosis and an ectostosis, especially in the palate. The frogs and toads vary greatly in the intensity of their ossification; the parostoses pass into superficial dermal plates, and the bones, both superficial and deep, are apt to begin in a wild way, not keeping to the habitual landmarks. This is seen also to a less extent in Urodeles.

The mind of man is not able to invent a more wondrous

transformation than that which actually takes place in the life of every frog and toad. Born almost a lamprey, it changes into a creature which is a Selachian, and something more; for it passes through the further border of the sharks and skates, in their territory, and begins in its changing growth to make the rudiments, at least, of many an important organ which comes to its perfection in man and his nearest relatives. The growth force then fetching in improvements and additions from many a quarter, and combining all things skilfully, makes a new thing on the earth.

(To be continued.)

THE NEWEST EXPLOSIVE

GUN-COTTON and dynamite, which have for some years past held the foremost rank among modern explosives, are no longer, it seems, to retain this honour undisputed. A compound more violent still than either of these well-known preparations has lately been given to the world by M. Nobel in the shape of blasting-gelatine, and blasting-gelatine, again, has been endowed with still greater energy by a modification in its nature, effected by Prof. Abel, the War Department chemist. So far as experiment has shown, the gelatine and modified gelatine are, without doubt, the most active explosive agents known to us, or, in other words, a given weight of these compounds will work more destruction upon metal, stone, or other unyielding mass, than any of the hundred and one bodies of a like character with which we have become acquainted during the past half-century.

It is a well-known circumstance that, with but very few exceptions, the many explosives that have lately been brought before the public under a variety of names are merely modifications of one and the same thing. They are all nitro-compounds, or modifications of them. One class owe their origin to gun-cotton and the other to nitro-glycerine, and gun-cotton and nitro-glycerine are by the chemist regarded as the same thing. Gun-cotton is made by the nitrification of a solid body, and nitro-glycerine by the nitrification of a liquid body. The methods of manufacture are similar, and the agents employed to bring about the nitrification are the same. In the one instance a woody fibre—cellulose—is acted upon by a mixture of strong nitric acid and sulphuric acid, the former liquid to perform the operation of nitrification, by substituting certain equivalents of nitrogen for the hydrogen existing in the cellulose, and the latter acid for the purpose of absorbing any moisture given off in the substitution process, and thus preventing the nitric acid from becoming dilute and inefficient. In the other, a liquid—glycerine—is permitted to combine in small quantities at a time with a mixture of the same acids, and in like manner parts with its hydrogen, to be replaced by nitrogen.

There is, however, this wide difference in the application of the two compounds. Gun-cotton may be employed as it stands, and the Abel gun-cotton that is used by our soldiers and sailors for torpedoes and mining work is simply a pure pyroxilin, pulped fine to permit of its being thoroughly washed, and compressed into *papier-maché* sort of blocks, for the sake of convenience. Nitro-glycerine, on the other hand, being a liquid, is difficult to handle in that form, and for this reason it is that Nobel and others cast about for suitable vehicles to contain the preparation. A siliceous clay called Kieselguhr, which will absorb three times its weight of the liquid, has been found the most favourable substance, and dynamite, generally speaking, may be said to consist of 75 per cent. of nitro-glycerine and 25 per cent. of this inert substance. In lithofracteur, other substances besides, are employed, such as powdered charcoal and nitre, and there now exists a whole family of such combinations, none of which contain, however, more than 75 per cent. of the active explosive, nitro-glycerine.

In blasting gelatine, which, by the way, contains no gelatine at all, the objection to employing an inert material is got rid of altogether, and the mass, like compressed gun-cotton, is explosive and combustible throughout. Blasting, or explosive, gelatine is a mixture of nitro-glycerine and gun-cotton. M. Nobel, to whom is due the credit of having placed the valuable properties of nitro-glycerine at the disposal of mining-engineers, has discovered, in the pursuance of further investigations, that the liquid in question acts as a solvent upon gun-cotton. Like a mixture of alcohol and ether, nitro-glycerine is found to dissolve nitro-cellulose, and form a description of collodion, or, as M. Nobel terms it, gelatine. It is not, of course, the highly-explosive gun-cotton that will thus dissolve, but that known as photographer's pyroxilin, which does not contain so much nitrogen. Military gun-cotton, indeed, or tri-nitro-cellulose, to call it by its chemical name, should not be soluble at all, or at any rate only to a slight extent, if properly manufactured, and one of the tests to ascertain if it is of good quality is in fact to treat it with an alcohol-ether mixture to ascertain how far it will dissolve. The soluble gun-cotton, however, if not so highly nitrified, to coin a term for our purpose, is still a sufficiently explosive body, and this M. Nobel finds he can dissolve to a greater extent in nitro-glycerine than it is possible to do in alcohol and ether. Whereas the latter will dissolve no more than 4 or 5 per cent. of pyroxiline, and frequently less than 2, nitro-glycerine has been found to take up upwards of 7 per cent. The operation of dissolving is presumably done when the liquid is warm, and the result is, as we have said, a jellified mass, which has all the attributes of a definite combination. There is no separation of liquid from the mass, and cartridges may be made by simply rolling up the material in paper envelopes.

Thus, in blasting gelatine, there is no inert body, and the consequence is that weight for weight, the gelatine is superior in its destructive action to dynamite. The latter, as we have seen, contains 75 per cent. of nitro-glycerine, whereas blasting gelatine consists of from 90 to 93 per cent. of this liquid, and from 7 to 10 per cent. of soluble gun-cotton. But there exists another reason still, why the detonation of blasting gelatine should be more energetic, namely, because the combustion of the charge, from more perfect oxidation, is well nigh perfect. Prof. Abel pointed this out very clearly in his recent lecture at the Royal Institution. "As nitro-glycerine," he said, "contains a small amount of oxygen in excess of that required for the perfect oxidation of its carbon and hydrogen constituents, while the soluble gun-cotton is deficient in the requisite oxygen for its complete transformation into thoroughly oxidised products, the result of an incorporation of the latter in small proportions with nitro-glycerine, is the production of an explosive agent, which contains the proportion of oxygen requisite for the development of the *maximum* of chemical energy by the complete burning of the carbon and hydrogen; and hence," Prof. Abel concludes, "blasting gelatine should, theoretically, be even slightly more powerful as an explosive agent than pure nitro-glycerine."

By converting the gelatine into a more solid body by the addition to it of some 10 per cent. of military gun-cotton, or tri-nitro-cellulose, Mr. Abel appears to have secured a still more vigorous explosive, and one besides, that, by reason of its firmness, is more convenient to handle than the softer and pliant jelly. The destructive action of this modified gelatine upon iron plates and heavy masses of lead, has been found greater than that of any other form of nitro-glycerine or gun-cotton, and there is no room for doubt that for torpedoes and military mining, where the object is to secure the greatest degree of violence, regardless of consequences, the compound will find valuable application.

While on the subject of nitro-glycerine and its behaviour

as a detonating agent, a few words may be said upon the report of the Chief Inspector of Explosives that has just been issued by the Home Office. If only because it controverts a popular notion as to the dangers of this substance in a frozen state, the report in question is of considerable interest. Ever since the disastrous accident at Newcastle-upon-Tyne, when Mr. Mawson, the mayor of the city and several others lost their lives through the explosion of some packages supposed to have contained frozen nitro-glycerine, a wholesome dread of this substance has been entertained. But, strange to say, Major Majendie and Mr. E. O. Brown, of Woolwich, who appears to have been associated with the Chief Inspector in these experiments with frozen nitro-glycerine, found the latter far less sensitive either to blows or to fulminate powder than when in its ordinary condition. In some cases the frozen material allowed itself to be scattered by the violence used, without detonating at all, and it was only by using a very large charge of fulminate powder that its explosion succeeded. Frozen dynamite was still more obstinate, and under some circumstances, indeed, its detonation appeared almost impossible. Another circumstance of an unexpected character presented itself in these experiments. Mr. Brown found that the solidification of nitro-glycerine—a phenomenon that usually happens very readily some degrees above the freezing-point of water—is particularly difficult to bring about when the liquid is in a pure state. Continued subjection of the pure liquid to a temperature below freezing-point failed altogether to effect its solidification, and it was only upon the addition of a few grains of a solid body that the desired result was secured. The reason, therefore, why commercial nitro-glycerine so readily solidifies at a comparatively high temperature is obviously because it is not perfectly pure. H. BADEN PRITCHARD

THE BRITISH MUSEUM LIBRARY

IN NATURE, vol. xix. p. 253, attention was drawn to the state of the literature of science as available for reference in the library of the British Museum. The publications of scientific societies, home, colonial, and foreign, and those of the scientific departments of different governments, were especially mentioned both as defective in regard to completeness of series, and as difficult to find in the catalogue.

Pending steps being taken to secure some approximation to completeness of series, which must take time, it may be useful to offer some suggestions with regard to the cataloguing, a modification in which would save much time to readers. Any fundamental alteration would no doubt be undesirable, for from a librarian's point of view, the cataloguing at the British Museum has been so often pronounced excellent. There is, however, also the worker's point of view, and if the catalogue is not one which, after years of experience he can easily use, it is not to be accounted as perfect.

The simplest solution of the present difficulty would be to have printed a separate list, such as the Patent Office periodically prints, "a list of the scientific and other periodicals and transactions of learned societies in the free library." Should there be, however, a financial difficulty in the way of carrying this out, it would be a saving of time to readers if these transactions, proceedings, &c., of societies were entered in some distinctive way, such as by a coloured ink, or even by a stroke in the margin, so that they might be easily picked out from bye-laws, lists of members, reprints of separate papers, &c. Several of the older societies occupy many pages in the special catalogue "academies." It is the publication of the societies containing the papers that are, of course, most frequently wanted, but these are so mixed up with other entries, that it takes time to find their press mark. Further than that, different series, when such exist, have different press marks, and it is not every one who has a date and a volume number for reference that knows whether there is more than one series, so a wrong press-mark may be given. In some cases there are two or three sets, more or less incomplete, of a series of publications, some, perhaps, in the King's library, some in the Granville, some in the general library, &c. This is very confusing, as it is only in a few cases that any note is made of the extent of incompleteness, and if the wrong set should be written for, it involves the loss of at least half an hour, and on busy days probably an hour.

If all the serial publications of a society were given at the head of the entries of that society, or even if only marked in the margin as just suggested, it would save a reader much time in finding the press mark, and would also save still further time often by giving the press mark for the part of the series which contains the volume wanted.

There is another point which is worth consideration, and that is whether those who are known to use the library for purposes of research could not be in some way put on a different footing from those who go simply to read. It would not be an innovation, but only an extension of a principle already recognised. For example, if a reader wishes to consult certain MSS., he is taken into a separate room, if he wishes to consult some of the older or rarer books, there is another room for such purpose, and there is but little time wasted in bringing him what he wants. Students are admitted to the natural history collections on days when they are closed to the public. There are a large number of people who use the museum for other purposes than work. They write their letters, read their magazines and newspapers, go round among their friends and gossip, write a ticket for some interesting book of travel or a novel, and read bits of it in the interval of receiving visits. Not a few appear to go there for a rest. The objection to all this is that these people occupy seats, and it is becoming more and more difficult for a reader with many books out at once for consultation or search to find table space. It is a very trying thing for a writer with references to verify or to follow up, to see while he is waiting for his books that the time of attendants is occupied in fetching novels that can be bought at any railway book-stall, or pieces of music that can be obtained for a few pence. (It may be mentioned in passing that for the cataloguing of comic songs and dance music, the British Museum is unsurpassed in excellence.) It must require a strong sense of the immorality of making quotations or references second-hand, to give a man patience under the circumstances. If the works are wanted for reading there is of course no help but waiting.

Surely there might be some distinction made between those who go to the reading-room for systematic work, and those who go for amusement. The British Museum reading-room is something more than a library for Londoners; people come up to town on purpose to consult it. It is a national library. An average mechanics' Institute would supply the wants of many who now use the Museum, occupy seats there, and take up the time of attendants. There are other free libraries in London besides the British Museum.

If it is not found practicable to make a distinction for workers generally it might be worth while to try how it would do to have tickets of a special colour for "Academies" and that these should not be obliged to wait their turn with tickets for novels. There are already white and coloured slips in use.

It would be a great advantage if the publications of societies and scientific departments of governments were kept all together and placed directly under the care of an officer who should see to their being kept up in completeness.

ON THE FIGURE OF THE EARTH

THE columns of NATURE recently contained an interesting series of articles on this subject, with notes. One of these notes, which I here repeat, has a

peculiar interest. The author says: "The theory was next propounded that the earth was an ellipsoid of three axes, but the proposition was not fully supported by the evidence." Upon this Col. Clarke remarks: "This is scarcely correct; the figure of three unequal axes agrees better with the observations than does the spheroid of revolution. But there is a necessity for this, and the ellipsoidal figure cannot be regarded as established."

I venture to think that this note ought to be printed in capital letters. It condenses, especially in the words, "but there is a necessity for this," the following important paragraph in the preamble to Col. Clarke's well-known paper in the *Memoirs* of the Royal Astronomical Society, 1861:—

"Whatever the real figure of the earth may be, if in the investigation we suppose it an ellipsoid, it is quite clear that the arithmetical process must bring it out an ellipsoid of some kind or other, which ellipsoid will agree better with all the observed latitudes, as a whole, than any spheroid of revolution will. Nevertheless it would scarcely, I conceive, be correct to say we had *proved* the earth not to be a solid of revolution. To prove this would require data which we are not in possession of at present, which must include several arcs of longitude. In the meantime it is interesting to ascertain what ellipsoid does actually best represent the existing measurements."

It may seem superfluous, so far as the main point is concerned, to add anything to these quotations: but of the three which have been given, I have very little doubt that the first was by way of a protest against the fallacy which, in spite of the last, has gained such a remarkable currency. Am I mistaken in thinking that it *is* a too-prevalent opinion that the equatorial section has been *shown* to be elliptical? It may be so; but I conceive it to be so noxious an error, when it does exist, that it is better to give too much than too little currency to every authoritative corrective of such an error.

It is very much to be regretted when investigations which are essentially *tentative*, and which are carefully guarded as such by sentences which are to be found if looked for, obtain through no fault of their own the character of demonstrations. I think Col. Clarke has run the risk of giving to the above fallacy a stronger hold by neglecting to emphasise with sufficient force, in his more recent calculations, their true character; and perhaps still more by seeming to entertain something of an expectation that the arithmetical result will be substantiated by increased data. Writing of the later result—as to which we may properly note that the equatorial major axis occupies a position differing from that of the former by 24° of longitude—he says: "But too much confidence must not be placed in it: as yet it is merely indicated by the existing observations, and the amount of the eccentricity of the equator shown is really very minute."

I am unwilling to seem to differ from so high an authority, especially on a point which I wish to have "reserved:" I therefore refrain from inquiring whether any such expectation is really entertained, preferring to adduce some arguments which tell the other way.

Whatever the real figure of the earth may be, it is as certain that, if we knew it exactly in every part—instead of only very uncertainly in a very few—a triaxial ellipsoid could be found which would fit it better than any other triaxial ellipsoid, as it is that a biaxial ellipsoid could be found which would fit a given egg better than any other biaxial ellipsoid. But we happen to know that eggs are generally egg-shaped, and not elliptical. So also we know—I hope it is not necessary to stop to prove this—that the earth is earth-shaped, and not ellipsoidal. If the best possible ellipsoid were fitted to it, the two would disagree everywhere more or less. It is not, therefore, as regards the present argument, a question of more data. If the figure were conformable to any ellipsoid, the existing data would suffice. Their insufficiency proves the non-conformity, and additional data cannot disprove it.

What additional data may be *expected* to do is to modify the approximate ellipsoid until the ellipticity of its equator disappears—in other words, until it becomes an elliptic spheroid.

Can I give any ground for this expectation? It would be fair to ask in return, Can any ground be shown for expecting a body, believed to have acquired its spheroidal form by rotation, to have an equator not circular? I will answer the latter inquiry first, myself. The same, or similar, causes which distributed land and sea irregularly have probably produced an equator which is not circular. But I know nothing to lead me to expect that the form of the equator has any better claim to be considered elliptical than circular, than this—an ellipse can generally be found which will fit an irregular area better than a circle. This argument can be turned against me, but only by admitting the irregularity. If the irregularity is admitted, I concede *an* elliptic equator for the approximate or mean figure. And the question is now reduced to one of degree.

The difference of equatorial semi-axes in Clarke's earlier investigations was 5,308 feet (1861), and subsequently 6,378 (1866). It is now 1,524 feet.

We are here, to go no further, within the limit of inequality assignable to the larger disturbances of sea-level; that is to say, to one kind only, of local irregularity.

In short, while I recognise with the most unreserved respect and admiration the labours which have resulted from the first attempt to ascertain whether a tri-axial ellipsoid was sufficiently indicated to be probable, I presume to think that Colonel Clarke's words of caution demand the utmost attention, and that the results at which he has arrived should be construed rather as disproving than as proving the reality of a sensibly elliptic equator.

I should extend this article too far if I did more than indicate one other ground for caution in describing the figure of the earth. Our knowledge on that head, as derived from arc-measures, is deceptive in proportion as we lose sight of the significance of the fundamental assumption that the figure is a regular one. Gross assumptions which suit an early stage of an inquiry may have to be abandoned later. The forms of the surfaces whose curvatures arc-measurements determine, are in any case local and particular; and so soon as local character appears, further consideration of the assumption is demanded. This, no doubt, is the reasoning out of which the tri-axial ellipsoid grew. It must not stop there. The tri-axial ellipsoid is not the only next step. Forced by the rigour of observation to abandon the elliptic spheroid as a final definition, and to admit irregularities as coming now within the range of more particular inquiry, the problem has in effect changed its face. To cling to the old assumption is to delay the recognition of the new phase. To look for additional data as means of substantiating or modifying an empirical modification of it is to halt in the presence of the larger problem which is opening before us.

Will it not be wiser to change the mode of attack? To bestow increased attention on the causes of irregularities and the probable magnitude of their effects? To theorise and calculate in this direction, on the one hand, and to extend experiment on the other, where such reasoning shall point the way? If we do this, the ultimate inadequacy of arc-measurements must receive recognition. The most obvious of all the causes of irregularity—the fluidity of the ocean and its obedience to the attraction of the land masses, must, one would think, invalidate their evidence materially. If, further, we consider the

actual conformations of the great terrestrial divisions of land and sea, arcs of longitude are, I imagine, especially likely to be affected by such causes.

The views which I have now attempted to express are by no means new, but it has not appeared necessary to cite authorities. I am indebted to many writers, but I should be sorry to have to assign to each the measure of the influence which his learning has had on the drawing up of this brief, which I hope some geodesist will now take up and argue more fully and more ably.

Dehra J. HERSCHEL

THE ROYAL SOCIETY SOIRÉE

ON Wednesday last week the President of the Royal Society gave a *soirée* at Burlington House, which was largely attended, and at which a considerable variety of apparatus were exhibited and many experiments made. Mr. Crookes showed his exhausted tubes and other apparatus, illustrating various phenomena connected with molecular physics in high vacua. The experiments made by these were the following:—

1. *Dark Space round the Negative Pole.*—When the spark from an induction coil is passed through an ordinary vacuum tube, a dark space is seen round the negative pole. The shape and size of this dark space do not vary with the distance separating the poles; nor, only very slightly, with alteration of battery power, or with intensity of spark. This well-known dark space appears to be a layer of molecular disturbance identical with the invisible layer of molecular pressure or stress, the investigation of which has occupied the exhibitor some years.

2. *The Electrical Radiometer.*—An ordinary radiometer is furnished with aluminium cups for vanes. The fly is supported by a hard steel cup, and the needle point on which it works is connected with a platinum terminal sealed into the glass. At the top of the radiometer bulb a second terminal is sealed in; the radiometer can therefore be connected with an induction coil, the movable fly being made the negative pole. At low exhaustions a velvety violet halo forms over each side of the cup. On increasing the exhaustion the dark space widens out, retaining almost exactly the shape of the cup; the bright margin of the dark space becomes concentrated at the concave side of the cup to a luminous focus, and widens out at the convex side. On further exhaustion, the dark space on the convex side touches the glass, when positive rotation takes place.

3. *Green Phosphorescent Light of Molecular Impact.*—At very high exhaustions the dark space becomes so large that it fills the tube, and when German glass is used the sides are beautifully illuminated with a greenish yellow phosphorescent light.

4. *Projection of Molecular Shadows.*—The rays exciting this green phosphoresence will not turn a corner in the slightest degree, but radiate from the negative pole in straight lines, casting strong and sharply-defined shadows from objects which happen to be in their path. The best and sharpest shadows are cast by flat disks, and not by narrow pointed poles; no green light is seen in the shadow itself, no matter how thin, or whatever may be the substance from which it is thrown.

5. *Magnetic Deflection of the Trajectory of Molecules.*—The stream of molecules, whose impact on the glass is accompanied by evolution of light, is very sensitive to magnetic influence, and the shadow can be deflected by bringing a small permament magnet near, the amount of deflection of the stream of molecules being in proportion to the magnetic power employed. The trajectory of the molecules forming the shadow is curved when under magnetic influence.

6. *Focus of Heat of Molecular Impact.*—Great heat is evolved when the concentrated focus of molecular rays from a nearly hemispherical aluminium cup is allowed to fall on a strip of platinum-foil, the heat sometimes exceeding the melting-point of platinum.

7. *Mechanical Action of Projected Molecules.*—An actual material blow is given by the impinging molecules. A small vaned wheel being used as an indicator, by appropriate means the molecular shadow of an aluminium plate is projected on the vanes. When entirely in the shadow the indicator does not move, but when the molecular stream is deflected so that one-half of the wheel is exposed to molecular impact it rotates with extreme velocity.

8. *Phosphorogenic Properties of the Molecular Stream.*—Substances known to be phosphorescent under ordinary circumstances shine with great splendour when subjected to the negative discharge in a high vacuum. (*a.*) *Becquerel's Luminous Sulphide of Calcium* shines with a bright blue-violet light, and when on a surface of several square inches, is sufficient to faintly light a room. (*b.*) *The Diamond* is very phophorescent. Most diamonds from South Africa phosphoresce with a blue light. Diamonds from other localities shine with different colours, such as bright blue, apricot, pale blue, red, yellowish green, orange, and pale green. One large fluorescent diamond gives almost as much light as a candle when phosphorescing in a good vacuum. (*c.*) *The Ruby* glows with a rich full red, and it is of little consequence what degree of colour the stone possesses naturally, the colour of the phosphorescence is nearly the same in all cases.

Besides these experiments the working of the writing telegraph, exhibited by Mr. E. A. Cowper, attracted much interest. The nature of this invention we described when it was first announced, and gave a specimen of the kind of writing produced. Other exhibits deserving notice were Prof. Guthrie's broken glass in frames, illustrating the fracture of colloids, Edison's loud-speaking telephone, Messrs. Preece and Stroh's synthetic curve machine, and frame of curves produced thereby; their automatic phonograph, electromagnetic vowel-sounder, stereoscopic curves, synthetic sounder and syren, and phonautograph. Apparatus and instruments of various kinds were also exhibited by Messrs. Browning, Hilger, and Tisley and Co. Among Mr. Hilger's exhibits was a quartz spectroscope for the ultra-violet rays, constructed for the Scientific Society of Stettin, under the direction of Dr. Schönn.

A NEW CALENDAR CLOCK

IT has always been a matter of surprise that the Americans can produce their well-known eight-day clocks in such large quantities, so uniformly good for ordinary purposes, and at such very moderate cost. Their general efficiency is proved by the increasing demand for them; not only are they sold in the American made cases, but separate movements are extensively imported and cased in England. One of the largest firms by which they are produced, that of Seth Thomas and Co., at Thomaston, Conn., has recently introduced a library or office clock of very moderate cost, one form of which is shown in the accompanying figure. This consists of the ordinary eight-day striking movement supplemented by an interesting and ingenious mechanism for operating the calendar; by its means not only the month and day of the week and month are indicated as in ordinary calendars, but the several months have their allotted number of days, an additional day being given to February in leap-year. Of course contrivances for effecting this object have long been known, but they always add so materially to the cost that they are prevented from coming into general use.

It would be impossible to fully explain the mechanism employed without the aid of drawings; a general description must therefore suffice. As will be seen, the calendar dial is placed below the clock dial, and is divided on its

circumference from 1 to 31. Two openings on a horizontal diameter allow drums to show the month and day of the week respectively, and a central hand points out the day of the month. A cam, formed like the snail of an English striking-clock, but without the steps, is caused to rotate once in twenty-four hours by the clock movement, so that a pendant, resting on it, is raised through a space of about 1 inch in that period and allowed to fall, the weight being supplemented by the tension of a spiral spring; this is the sole connection between the calendar and clock. During the ascent of the pendant a detent passes over one tooth of a wheel fixed to the week-day drum, which is thus carried round through a corresponding interval when the release occurs. At the same time a precisely similar action, performed on a wheel fixed to the axis that carries the hand, causes it to advance one figure.

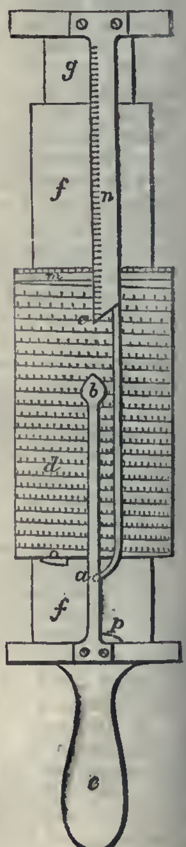
Just as the cam driven by the clock accomplishes the change from day to day, so a second cam on the central axis of the calendar alters the month; the detent, on being released, carries forward one tooth of a 12-toothed wheel. It remains to explain the device for allotting the requisite number of days to each month and correcting

8-day Parlour Calendar, No. 4. Height 25 inches. Spring-Strike. 8-inch Dials.

for leap year. The axis of the month drum carries an irregular shaped cam, which may be conceived to be divided radially into twelve parts. Those arcs of the circumference that correspond to 31-day months are left untouched; 30-day months have their arcs filed away to the corresponding chord; and for February a depression is made equal to three times that of other months such as April. A light spring holds a bent arm against this cam, the arm being so placed that at the end of each short month it can ride on a metallic arc carried round with the hand; the acting length of this arc corresponds to one or three teeth of the dial-wheel if the 30th or 28th is the last day, and the arm entirely escapes it when thirty-one days are to be indicated. Whenever it is thus held out of its natural position, the arm prevents the check-spring that limits the movement of the dial-wheel from falling into its place, and the detent is thus enabled to advance the hand through two or four spaces instead of the usual one. An additional day is given in leap-year by a simple application of the well-known sun and planet wheel of Watt. The central fixed wheel is coaxial with the month-drum and has sixteen teeth; the planet-wheel, pivoted on the cam, has twenty teeth, and carries a sector of such a radius that, when superposed on the February depression, it diminishes the fall of the arm so that it rides on an arc corresponding to two teeth instead of three. It will be seen that the above numbers of teeth are so chosen that the wheel carrying this sector is only brought into an identical position once in every four (annual) rotations of the month-drum; the necessary correction is therefore effected.

SPIRAL SLIDE RULE [1]

THE method of multiplying and dividing by means of a rule was first introduced by Gunter about the year 1606 by the construction of a scale of two equal parts divided logarithmically, the readings being taken off with a pair of compasses. Oughtred about 1630 invented the rule composed of two similar logarithmic scales sliding in contact, but the difficulty of estimating the reading between two graduations then first became important. It is easy to see that it requires but little practice to place a graduation in one scale opposite to a position obtained by estimate between two graduations in the other scale, but it becomes a much more tiresome and uncertain process when both of the readings required to be placed in juxtaposition fall between two graduations on their respective scales. With practice, however, this operation can be effected with considerable accuracy provided the graduations are not too close together; hence to enable the calculations to be performed with a sufficient degree of approximation there has always been a desire to increase the scale and consequently the total length of the instrument. To attain this object and at the same time preserve the portable size of the instrument Prof. Everett designed his slide rule, but the range of this is now far surpassed by the invention by Prof. Fuller of the spiral slide rule.



The instrument can be readily understood from the accompanying figure.

d is a cylinder that can be moved up and down or turned round on the cylinder *ff*, attached to and held by the handle *e*. Upon *d* is wound in a spiral a single logarithmic scale. Two other indices, *c* and *a*, whose distance apart is equal to the axial length of the spiral, are attached to the cylinder *g*, which slides in *f* and thus enables the operator to place them in any required position relative to *d*. *o* and *p* are two stops which when placed in contact bring the index *b* to the commencement of the scale. *m* and *n* are two scales, one attached to the movable indices and the other to the cylinder *d*.

By the spiral arrangement the length of the scale can be made very great, and as only one scale is required the effective length is double that of an ordinary straight rule. The scale is made 500 inches, or 41 feet 8 inches long, and the instrument is thus equivalent to a straight rule 83 feet 4 inches long or a circular rule 13 feet 3 inches in diameter. The first three digits of a number are printed on the rule throughout the scale, much increasing the facility of reading off. The method of using the different indices will be best understood by examples. For multiplication—bring 100 to the fixed index *b* and place the movable index to the multiplicand,

[1] By George Fuller, M.Inst.C.E., Professor of Engineering, Queen's University, Ireland.

then move the cylinder so that the multiplier is at the fixed index. The product is read off at one of the movable indices, bearing in mind that the number of figures in the product is the algebraic sum of the number of figures in the multiplier and multiplicand, if it is not read upon the same index as the latter, but it is one less than that sum if read upon the same index. The use of the scales *n* and *m* is shown by the following: *n* being read from the lowest line of the top spiral and *m* from the vertical edge of the former. To find the value of 5^{13}: on placing *c* to 500 scale *n* reads ·68, and scale *m* ·01897, which gives ·69897 for the logarithm of 5. ·69897 × 13 = 9·08661. Next placing the cylinder so that it reads ·08661 on scales *m* and *n* the index *c* reads 12207, hence the required power is 1220700000 consisting of ten figures as required by the logarithm above. Where a considerable degree of accuracy is required we believe this slide rule will be found of much service, but it cannot compete on the one hand, on account of its somewhat cumbrous nature, with the ordinary patterns of slide rule for rough and ready work, or on the other with a table of logarithms for calculations requiring close approximation.

OUR ASTRONOMICAL COLUMN

A NEW NEBULA.—Dr. Tempel, of the Observatory of Arcetri, Florence, notifies his discovery of a nebula on March 14 in a part of the heavens which has been most rigorously scrutinised in searching for these objects. For this reason it was at first supposed to be a faint comet, and was compared with the seventh magnitude following, W.B. XI. 305; but on March 16 its place was found to be unchanged. Dr. Tempel says it is properly a double nebula, with two small but distinct nuclei, distant from 15″ to 20″, and he adds the nebula Herschel II. 32, which is in the vicinity, was on both evenings much smaller and fainter than the new one. Herschel's nebula is caught at once in slow sweeping with a 6 or 7-inch refractor, so that an object to be very decidedly more conspicuous, must be within reach of ordinary telescopes, and it is hardly credible that its appearance can have long been as Dr. Tempel now describes it, without its being previously detected. Mr. Lassell's Catalogue of 600 new nebulæ discovered at Malta contains several in the immediate neighbourhood, so that the observer, Mr. Marth, could hardly have failed to have his attention called to the object in question, if then as visible as at present. Dr. Tempel's nebula is obviously worthy of immediate and continued observation; its position for 1879 is in R.A. 11h. 18m. 5s., N.P.D. 86° 1′·4, or it precedes the seventh magnitude above named 1m. 27s., nearly on the parallel. Chacornac, in his Chart No. 34, has a star 12·13 mag. within about 3′ from the above position, but shows no nebulosity; this circumstance is of itself sufficient proof that the nebula was not visible twenty-five years since. We would suggest that the position of this object relatively to the stars near it should be determined with all possible accuracy; it will be remembered that the centre of condensation in the variable nebula in Taurus has appeared to oscillate about the point where it was first remarked in October, 1852; or, to speak perhaps more correctly, nebulosity has at times been quite imperceptible in the original place, though apparent at a very short distance from it.

BRORSEN'S COMET.—In No. 2,254 of the *Astronomische Nachrichten* Dr. Armin Wittstein of Leipsic has given an orbit and ephemeris for this comet, founded upon a correction of the elements of Prof. Schulze by means of observations at Leipsic on March 19 and 26. There appears, however, to be error in the work; the new elements differing much from an observation on April 14, and so far as we can see, it is probable that the ephemeris for May, which has appeared in NATURE, will be much nearer the truth than Dr. Wittstein's figures; at the same time it is to be remarked that the predicted elements require sensible correction, though not to such an extent as his calculations would indicate. Were it considered worth while, an orbit might be deduced from the observations already made at the present appearance, which would afford the means of following the comet closely during the remainder of its visibility, but the predicted elements with a correction to the time of perihelion passage, will doubtless suffice for finding the comet readily, as long as it is within reach.

RE-OBSERVATION OF TEMPEL'S COMET, 1867 II.—In a communication to the Paris Academy it is announced that the comet of short period discovered by Dr. Tempel in 1867, and observed again at its return to perihelion in 1873 after experiencing heavy perturbation from the action of Jupiter, was found once more by its original discoverer, at the Arcetri Observatory on April 24. At 14h. 30m. Florence mean time, its R.A. was 16h. 50m. 59s. and its declination 13° 32′ south, so that its position corresponds nearly with that given in the first of M. Raoul Gautier's three ephemerides in *Astron. Nach.*, No. 2,242, in which the perihelion passage is assumed May 6·9416 Berlin M.T. Dr. Tempel says he had searched for it in vain during the rarely fine nights of February and March. The comet is faint and diffused, with a granulated appearance about the centre, and 2′ in diameter. This granular characteristic of comets, by the way, is one which has been frequently noted by Dr. Tempel, and which other observers do not appear to recognise so often. He directed particular attention to it when announcing his discovery of the comet of the November meteors, 1866 I.

If the perihelion passage of the comet 1867 II. be assumed to take place, 1879, May 6·9537 M.T. at Greenwich, and the mean diurnal motion = 593″·184, with the other predicted elements of M. Raoul Gautier, it is probable that the comet's position will be given very nearly during its present appearance. The co-ordinate constants in his orbit, for apparent equinox of June 1, are:—

$$x = r\,[9{\cdot}99389],\ \sin.\,(v + 328^\circ\ 2'{\cdot}4),$$
$$y = r\,[9{\cdot}95727],\ \sin.\,(v + 242\ 33{\cdot}4),$$
$$z = r\,[9{\cdot}65727],\ \sin.\,(v + 218\ 41{\cdot}7).$$

GEOGRAPHICAL NOTES

THE steamer *Nordenskjöld*, Capt. Sengstake, belonging to Herr A. Sibiriakoff, is almost ready to sail from Gothenburg for Behring Straits, *viâ* the Suez Canal, to search for the *Vega*, along with the *Jeanette*, belonging to Mr. Bennett, of the *New York Herald*. Herr Gregorieff, of the St. Petersburg Geographical Society, sails with the *Nordenskjöld*. Herr Sibiriakoff is sending off two coast searching parties to Behring Straits, one from Nischni Kolymsk and the other from the mouth of the Anadyr.

THE current number of the Royal Geographical Society's monthly periodical contains ample evidence of the good work which is being done by our missionaries towards making geography. Dr. James Stewart contributes an account of the second circumnavigation of Lake Nyassa, Dr. Laws a report of his journey along part of the west side of that lake, and Mr. G. Blencowe notes on the physical geography of Zululand and its borders, based on nineteen years' experience on the Natal and Transvaal frontiers. The geographical notes are fairly good, the more important being those which describe a new route from the Caspian to Kungrad, and recent explorations in Persia and Central Australia, but we cannot refrain from expressing our surprise that in a periodical, which ought to be the leading authority on geography, more space is not devoted to this department, the most important of all, for therein should be recorded brief accounts of all that is being done in the way of travel and exploration throughout the world. It will interest many of our readers to learn that the full text of

Prof. Geikie's able lecture on geographical evolution is promised for the June number.

We understand that, chiefly through the instrumentality of a veteran Arctic officer, the Council of the Royal Geographical Society were some time back induced to urge upon H.M. Government the propriety of despatching a vessel to the relief of Prof. Nordenskjöld early in the present season. The matter, of course, was referred to the Admiralty, and "My Lords," after mature deliberation, have arrived at the conclusion that the matter had better be left to private enterprise. This resolution may be looked upon as a tolerably sure indication that the present Government are not disposed to embark upon an Arctic expedition of any description.

We hear that Mr. Keith Johnston, the leader of the Geographical Society's East African Expedition, was to leave Zanzibar at the end of last month for Dar-es-Salaam, on the mainland, with the view of making final preparations for his journey to Lake Nyassa. The fact of his having been fortunate enough to secure the services of Chuma, Livingstone's old follower, will, no doubt, smooth away many difficulties, which otherwise would have caused him much trouble. Mr. Johnston has, we believe, turned his somewhat lengthy stay at Zanzibar to good account in the accumulation of all the information that could be procured respecting the tribes through which he will have to pass; and in this matter he has received very great assistance from an Arab named Bushire bin Selim, who is acquainted with some part of the country between the coast and Lake Nyassa, and who states that, though there is no direct road from the coast, the region at the north end of the lake is regularly visited by branch routes from the main road between Bagamoyo and Ujiji.

M. de Semellé, whose death was we are glad to say prematurely announced, has succeeded in ascending the Niger and the Binué as far as Okeri, a point, it is stated, which has not hitherto been explored. He has collected valuable information on the products of the country, and the history and traditions of the people. He intends meantime to return to France for further subsidies to enable him to continue his exploration. M. Soleillet, who had to return to St. Louis in Senegal, after reaching Segou, is to set out on a new expedition for "Tichid, Wallatana, Timbuctoo, the Touat, and Algiers." M. Soleillet has brought back much interesting information concerning the people among whom he has been travelling, and of whom he speaks in very high terms for their intelligence and culture.

M. Savorgnan de Brazza is about to set out for further exploration in the Ogowé region; he will endeavour to penetrate to the interior by the Alima and the river into which it falls.

In No. 4 of the *Mittheilungen* of the Vienna Geographical Society, Count Stefanovic von Vilovo discusses the causes of the recent disastrous floods at Szegedin. Five years ago, it seems, he prophesied that some such catastrophe must happen, but he was only laughed at. He showed that this would be caused by the damming back of the water in the narrow rocky passes at Plocsa, and in the Kazan, in the narrow pass between Bazian and the Iron Gates, the surplus water being thus forced back into the nearest tributaries, the Morava, the Temes, the Save, and above all the Theiss. He maintains that the present disasters are solely the work of those rocks at Plocsa and in the Kazan, preventing the carrying off of the unusual quantity of water thrown into the river by the rains and snows of last autumn. Dr. Holub's paper on the Marutse-Mambunda is continued, with many illustrations and vocabularies, as also the papers of Prof. Benoni, on the sources of the Dniester, and Hesse-Wartegg's, on the river-bed of the Mississippi. Herr von Hochstetter contributes an illustrated paper on the magic instruments of the rain-maker among the natives of Inner Australia.

A letter from Herr Déchy, dated Darjeeling, March 9, in the *Mittheilungen* of the Vienna Society, states that in a day or two he expected to leave with a well-equipped expedition for exploration in Western Sikkim. He was to go through the valley of the Great Runget to the south foot of Kinchingunga; thence, climbing the Pundim-Nursing ridge into the Testa Valley, he was to explore the valleys, mountains, and passes of the Thlonok and Zemu rivers. Herr Déchy expects to add much to our imperfect knowledge of these regions, and his expedition is well supplied with instruments for scientific observation.

The new number of *Les Annales de l'Extrême Orient*, which is doing good service by its translations of the accounts of Dutch explorations in Oceania, &c., contains remarks by H. von Rosenberg on the Schouten Islands at the entrance to Geelvink Bay, New Guinea, and brief notes by M. van Hasselt on Alahan-Pandjang in Sumatra, accompanied by a map. This periodical, it may be mentioned, records the proceedings of the Société Académique Indo-Chinoise.

We understand that Prof. P. J. Veth, of Leyden, the learned president of the Geographical Society of the Netherlands, has been elected an honorary corresponding member of the Royal Geographical Society.

We learn from the *Colonies and India* that a very interesting operation has been performed in the Thames River, New Zealand, viz., the blowing up of the Awotonga Falls, near the Awoka mountain. They were 75 miles from the mouth of the river, and had been a great hindrance to navigation. The falls were blown up with 200 lbs. of dynamite, the column of water rising to a height of 470 feet, and forming a magnificent spectacle. In addition to these falls, there have been removed in a similar manner several dangerous and impassable rapids and upwards of 500 "snags," varying from two to eight feet in diameter, and some of them 120 feet long. The clearing of this river, it is said, will open up a million acres of excellent land, which the Government have obtained from the natives.

TRENHAM REEKS

With much regret we record the death of Mr. Trenham Reeks, the esteemed Registrar of the Royal School of Mines, Jermyn Street. He had been ailing for some weeks, and last week the complaint assumed the serious form of inflammation of the lungs. There was still hope of his recovery a few days ago, but he expired on Tuesday morning, the 5th inst. By his death one of the oldest associations of the Geological Survey and School of Mines is severed. While still young he became connected with the infant museum established by the energy of his friend, Sir Henry de la Beche, in Craig's Court; and on the enlargement of that establishment and the creation of the School of Mines, he was appointed to the office which he has held up till now. Having in early life devoted himself to chemistry and mineralogy, he took great pride in the mineralogical collection under his charge in Jermyn Street, and from year to year enriched it with fresh acquisitions. He had a great knowledge of pottery, and gained it at a time when the taste was far less general than it is now. The illustrated hand-book which, in conjunction with De la Beche, he prepared of the ceramic collection in the Jermyn Street Museum, though long ago out of print, is still a valued work of reference. Personally, he was singularly courteous and obliging, though tenacious of purpose and not easily defeated in any matter wherein he had resolved to succeed. He thoroughly identified himself with the interests of the School of Mines, to which his loss must now be great.

Not a few who read these lines will long remember the

little, rather dingy, room in which, for well nigh thirty years, he has sat amidst blue-books, calendars, mineralogical specimens, and a rather orderly chaos of miscellaneous objects. They will think with sadness of the rupture of these old associations, and will follow to the grave with deep respect and sincere regret the old friend who has been so suddenly and unexpectedly removed from their midst.

WILLIAM GEORGE VALENTIN

IT is with much regret that we record the untimely and sudden death on the 1st inst. from apoplexy of Mr. William George Valentin. He was born in Neuenburg, in the Black Forest, on May 16, 1829. He came to England in 1855, and, in the early days of the Royal College of Chemistry, studied under Dr. Hofmann, who esteemed him greatly, and, recognising his ability, made him senior assistant in the laboratory, a position which he retained at the Science Schools, South Kensington, under Dr. Frankland. He held for some years the office of gas examiner to the Great Western Gas Company, and at the time of his death was chemical adviser to the Trinity House.

His chemical text-books are deservedly popular; and within the last few days he corrected the final proofs of a new work which is therefore nearly ready for publication.

Mr. Valentin was a successful and painstaking teacher, and the fact that so many of the well-known chemists of this generation have received their early training from him, sufficiently indicates the value of his work; it would be difficult, indeed, to find one to whom the younger chemists of the present day are more indebted.

Within the last few weeks a few of his old friends and students of the Royal School of Mines had intended to present him with a testimonial; the efforts of the committee formed for this purpose will now be continued for the benefit of his widow and family.

ELECTRIC LIGHTING

WE need not insist on the extreme importance and interest of the exhibition which was opened last night at the Albert Hall, and for which extensive preparations have been making for some time. The public mind both in this country and abroad has been recently much agitated on the question of electric lighting, and, as might be expected, people are much confused among the many systems which have been brought forward, and even those who know something of the subject must find it difficult to make up their minds. Hence the importance of bringing together the various systems of electric lighting in such a way as to make comparison possible. It must, moreover, have an important educational influence upon the general public, helping somewhat to give them a truer idea of what physical science is, and what it is capable of doing for the good of mankind. The exhibition was opened last night by an able and interesting lecture by Mr. W. H. Preece, the chair being occupied by the Prince of Wales.

The machines to be exhibited are not only those which have been recently attracting attention, but also older ones, which will exhibit in an impressive manner the history of the development of electric lighting. Thus there are in the arena of the Albert Hall specimens of Mr. Holmes's original magneto-electric machine, and of the Alliance Company's magneto-electric machine, lent by Trinity House, as well as the Siemens dynamo machine and the Gramme machine, now so much in use for generating electricity for lighting and other purposes. There are also varieties of the Gramme and Siemens machines, differing from each other more in minute detail than in general principle.

The Jablochkoff and the Lontin systems are also strongly represented. From the centre of the dome depend five large lamps of the Siemens pattern, round the upper corridor are ranged the Jablochkoff lamps exhibited by the Société Générale d'Electricité, and around the arena stand handsome specimens of the Lontin lamp, mounted on tastefully-designed posts. The Wilde lamp will also be strongly represented. This may be briefly described as the Jablochkoff candle with the central non-conducting substance left out. In addition to a powerful Gramme machine, the British Electric Light Company exhibit several lamps, notably the Serrin, hardly yet surpassed in some points of excellence, the Werdermann, Reynier, Higgins, and Rapieff lights, and it is stated that the Anglo-American Electric Light Company will exhibit the Wallace and the Iridium Incandescent lights, the last-named of which is of much the same kind as that employed by Mr. Edison. The distinguishing characteristics of these various lights were explained by Mr. W. H. Preece, and the exhibition, which will remain open to the public for the remainder of the week, promises to be by far the most attractive display of scientific apparatus made for some considerable time past.

It may not be inappropriate to give here a short account of a new form of electric lighting, which, it would seem, will not be represented at the exhibition now opened at the Albert Hall.

At last week's meeting of the Paris Academy, M. Jamin presented a model of an electric light for which he claims the greatest possible simplicity. The two carbons are kept parallel by two insulated copper tubes, separated by an interval of two or three millimeters, in which they slide by friction, and which serve at once to direct them and to guide the current. They are surrounded by a directing circuit composed of five or six spirals coiled on a thin rectangular frame ·40 m. long and ·15 m. broad. This circuit, traversed by the same current as the carbons, and in the same direction, guides and fixes the electric arc at the extremity of the points. The lighting is effected automatically. For this purpose, the two extremities of the carbons are surrounded by a thin caoutchouc band which keeps them close together. Between them, a little above, a small fragment of iron wire is introduced, which keeps them in close communication by a single point. As soon as the circuit is closed, the current traverses this wire, makes it red-hot, and melts the caoutchouc; the two carbons, thus freed, separate, and the arc is established with a sort of explosion. Carbons of any size may be employed, up to 8 mm. diameter. At this limit the waste scarcely exceeds ·08 m. per hour. By a proper arrangement the points may be maintained in their initial position. The apparatus may be suspended either with the points upwards or directed towards the ground. For several reasons, which Mr. Jamin states, the latter position is preferable. With its points downwards, then, M. Jamin claims for his light the following advantages:—1. That of simplicity, since it requires no mechanism and no preliminary preparation; all is reduced to a support and to carbons; (2) that of mechanical economy, since it succeeds in almost doubling the number of lights; (3) increase of illumination, since each of the new lights is nearly twice as powerful as the old; (4) quality of light, which is more white; (5) a more advantageous arrangement of the poles, which throw their greatest amount of light downwards, where it is required, instead of losing it towards the sky, where it is useless; (6) finally, economy of the combustible material, since the waste is less in proportion to the size of the carbons.

NOTES

WE greatly regret to announce the death at Rome, on April 14, of Prof. Paolo Volpicelli, the well-known Italian electrician. We hope to be able to give details of his life and work in an early number.

THE Council of the Society of Arts have awarded to Sir William George Armstrong, C.B., D.C.L., F.R.S., the Albert Medal "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power, hydraulically, due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided and mechanical power beneficially substituted for most laborious and injurious manual labour."

THE annual *conversazione* of the president of the Institution of Civil Engineers has been announced for Monday, May 26. Mr. Bateman, the president, will, by permission of the Lords of the Committee of Council on Education, receive his guests in those galleries belonging to the South Kensington Museum which contain the varied and extensive collection of engineering, naval models, drawing instruments, and machinery. Mr. Bateman invites the members of the profession and others to supplement that collection by the loan for the occasion in question of any similar suitable object.

THE *American Naturalist* states positively that the President has nominated Mr. Clarence King to the directorship of the U.S. Geological Survey, and from an article by Mr. A. S. Packard, in the same number, there seems no doubt that the appointment has been confirmed. The actual state of matters now is that the three surveys under Hayden, Powell, and Wheeler are to be discontinued after June 30, and to be replaced by a new U.S. Geological Survey, in charge of Mr. Clarence King. "It was," Mr. Packard states, "as far as we are aware, the original understanding, when the matter was referred by Congress to the National Academy of Sciences, to simply consolidate the existing geological surveys, but the report of the committee was so worded that these surveys were abolished outright instead of being consolidated. The amount appropriated for the new geological survey is 100,000 dollars, a little more than each of the other surveys has formerly received. Thus the work is apparently to be greatly curtailed, and science and the best interests of the Western people will, in a corresponding degree, suffer." We trust that this is too gloomy a view to take of the prospects of the newly-organised survey, though we fear that personal interests have had more weight in bringing about the new state of things than the interests of science of the United States. We understand from Mr. Packard that no provision has been made for carrying on biological observation along with the geological survey, a department hitherto admirably represented, and the work of which has made the U.S. Survey famous all the world over. We are sure it will not be with Mr. King's consent that zoology and botany will be ignored in the survey under his charge, and he may be sure that men of science of all nations will watch with interest the future work of that survey which hitherto has contributed so largely to scientific knowledge.

THE death is announced of Mr. Frank A. Bradley, a well-known American geologist; he was crushed to death by the caving of a wall of a gold mine in Georgia.

THE United States Congress has appropriated 10,000 dollars for the completion of the investigation of the Rocky Mountains by the United States Entomological Commission. The work during the coming season will be carried on in Colorado and the Western Territories, particularly Utah and Eastern Idaho.

MR. S. H. BRACKETT, of St. Johnsburg Academy, Vermont, writes to the *Scientific American*, claiming for Mr. Edward Farrar, of Keene, N.H., the discovery of the principle of the telephone in 1851. In support of the claim Mr. Brackett gives the following extracts from Mr. Farrar's correspondence of the time:—"Each reed of a melodeon is furnished with a small metallic point, which, while the reed is at rest, approaches near to the surface of mercury in a very small cup underneath the reed, into which the point dips when set in motion. The reeds are connected with one pole of a battery, and the cups with the other. The current is broken with each vibration of the reed. At the remote end of the wire is a temporary magnet, with an armature fixed upon a spring in near proximity to the magnet, and which is affected as a reed at the other end of the line is set in motion. The effect is that the armature vibrates with the reed set in motion, and, the pitch of a sound depending on the rapidity of vibration, it will be the same in the reed and armature. A tune on the instrument will therefore produce a tune on the armature. What may appear somewhat strange, several different tones may be heard when chords are struck upon the instrument. The object of my inquiry was this: *If the current power could be varied by some slight variation of a vibrator to be affected by the atmosphere as the tympanum of the ear is, the supposition is that the sounds of the voice might be reproduced* by the means stated above." When it is remembered that Mr. Farrar penned the above in May, 1854, it is to be regretted, we agree with Mr. Brackett, that he was turned aside from so interesting an inquiry at so critical a point.

THE chief work now in process of publication by the United States Geological Survey, we learn from *Science News*, is Dr. Joseph Leidy's "Monograph of the Fresh-water Rhizopods of North America." It will form a quarto volume of several hundred pages, enriched by numerous plates, and will be the twelfth of the series of "Final Reports." The author has been long engaged upon this book, and brings to the elucidation of this subject unequalled knowledge of the branch of which he treats. The introductory chapter furnishes a general account of the rhizopods, giving the characteristics which serve to identify them, telling where they dwell, how they live, in what way to catch them, and the proper method for studying them under the microscope and otherwise. The class Rhizopoda, Dr. Leidy separates into five orders, as follows: Protoplasta, Heliozoa, Radiolaria, Foraminifera, and Monera. Dr. Leidy confines himself to those species which inhabit American ponds and rivers.

THE following questions are proposed by the Belgian Academy for competitive treatment (the rewards offered being medals of 800 francs value each, except for the third of the first section, where the value is raised to 1,000 francs):—I. Section of Mathematical and Physical Sciences—1. Show the state of our knowledge of phenomena known under the name of *influence of masses*, and indicate why the ideas of Berthelot have yielded to those of Proust; also indicate, if possible, the way by which a solution of the general problem may be arrived at. 2. Find and discuss the equations of some algebraic surfaces of no mean curvature. 3. Complete, by new experiments, the state of our knowledge of the relations which exist between the physical and the chemical properties of simple and of compound substances. II. Section of Natural Sciences—1. Give a description of the tertiary strata belonging to the eocene series, that is to say, terminated superiorly by the Laekenian system of Dumont, and situated in Hesbaye, Brabant, and Flanders. 2. Describe the history of the germinative vesicle in ova capable of developing by parthenogenesis. (The author is free to choose any animal species in which parthenogenetic development has been proved to exist.) 3. New observations on the relations of the pollinic tube with the ovule, in one or more phanerogams. The memoirs to be clearly written in French, Flemish, or Latin, and sent, with motto and sealed packet, to the secretary, before August 1, 1880. Great exactness required in citations. Two questions are also proposed for 1881:—1. New researches on the germination of seeds, especially on the assimilation of nutritive deposits by the embryo. 2. Extend to eight points of a curve of the third order, the enharmonic property of four points of a conic.

THE Carpi prize of the Reale Academie de' Lincei for 1880 (value 500 lire) will be awarded to the author of the best monograph *On the Organs and Vital Functions of Plants*. Memoirs to be sent in before December 31, 1880. The conditions are the same as in 1878.

A NEW nautical instrument, called a *navisphere*, has been brought before the French Academy by M. De Magnac. It is meant to indicate, without calculation and promptly, the names of the stars above the horizon at a given moment (with altitude and azimuth), the angle of route for going from one point to another by the arc of a great circle, and the distance between these points (approximately). Spherical triangles may also be solved with it. The instrument consists of two parts, the one a celestial sphere with stars marked on it, resting on a spherical zone, to which all possible positions may be given; the other comprises the system of the horizon, the meridian, and the vertical, represented by a circle, a semicircle, and a quarter of a circle in metal. With this system of arcs one can trace arcs of a great circle on the sphere, and measure their lengths, also measure the angles formed by two great circles. The second part of the apparatus is called a *metrosphere*. The experiments with the *navisphere*, made on board the Atlantic steamship *Washington* appear to have been highly encouraging.

IN the spectral examination of the new earth recently extracted from erbine by M. Nilson, M. Thalén found the following lines proper to the spectrum of that substance. (*Comptes Rendus*, March 24.)

Colour of rays.	Wave-length.	Intensity.	Remarks.
Orange	6078·5	3	Broad and nebulous.
	6072·5	3	
	6054·0	5	Nebulous.
	6035·0	2	
	6019·0	4	Nebulous.
Yellow	5736·0	6	
	5729·0	6	
	5719·0	4	Very fine and clear.
	5710·5	4	
	5700·0	4	
	5686·0	4	
	5671·0	4	
	5657·5	4	
	5526·0	2	Strong.
Green	5089·0	6	Fine.
	5084·5	5	
	5082·3	4	
	5081·0	3	
	5030·0	3	
Blue	4742·5	3	
	4739·0	4	
	4736·5	5	
	4733·0	5	
Indigo	4404·0	„	
	4373·0	„	
	4323·0	„	
	4319·0	„	
	4313·0	„	
	4245·5	„	

Besides these lines, several others were observed which belong to the spectrum of ytterbium, and which have already been indicated by M. Höglund in the spectrum of erbium. For the new element M. Nilson proposes the name *scandium*, to denote its peculiarly Scandinavian origin.

THE International Congress of Americanists has issued its circular of invitations to a third session, to be held at Brussels from September 23 to 26, under the patronage of the King of Belgium and the presidency of the Count of Flanders. The city of Brussels will take charge of the Congress, and see to the proper accommodation and convenience of the members. The object of this organisation is the development of a knowledge of the early history of discovery and settlement in the Americas, as also all such facts in their prehistory as can be gathered by an inspection of the remaining monuments. The volumes of *Proceedings* contain a great deal of interesting and important matter, although the Society is rather open to the charge of credulity in accepting, apparently without question, many statements repudiated by American archæologists. This, however, would be remedied by a larger representation from North America; and it is much to be hoped that some of our more accomplished American historians and ethnologists may take part in the proceedings of the coming season.

IT is known that the first aërial voyage was made by Pilatre de Rozier, in company with the Marquis d'Arlandes, in a Montgolfiere, or heated air balloon, on November 21, 1783. Pilatre was also the first victim of aërostation; he perished along with his companion Romain by the fall of a balloon at Boulogne. Three pieces which belonged to the unfortunate physicist are exhibited in the museum there: his speaking-trumpet, mercury barometer, and thermometer. Recently some other precious relics from the same origin have been found in a drawer in the museum. They are chiefly a plaster medallion of Pilatre, a part of the painted cloth which covered the gallery of the balloon, and the flagstaff. Engravings of these and the former relics of Pilatre are given in a recent number of *La Nature* (April 26), which also reproduces a detailed account of the fatal ascent.

THE extent of variability in composition of atmospheric air is a question treated by Herr von Jolly in a recent communication to the Bavarian Academy. By two methods of measurement, the one eudiometric, the other based on weighing, he observed variations that are not quite inconsiderable. The air samples of the year 1877 (got 2 km. out of town) showed differences in the oxygen from 21·01 down to 20·53 per cent., and in 1875 to 1876 the highest and lowest proportions (obtained by weighing) were 20·96 and 20·47 per cent. respectively. The variations in the two years were thus nearly the same. The largest amount of oxygen occurred in both years when the polar current was prevalent; the smallest with the equatorial current or föhn. It is not affirmed, however, that whenever the wind is north or north-east, there is necessarily *more* oxygen, and when it is south and south-west, *less*; or that differences of 0·5 per cent. occur with every reversal of the wind. The more rapidly the directions of wind alternate, there is more mixture of air masses; and therefore there is never so much oxygen as with continuous polar current, or so little as with continuous equatorial. Whether from year to year the mean proportion of oxygen is the same, or whether, as is more probable (the duration of polar and equatorial currents varying from year to year), there are slight differences in this average, can only be determined by further observations.

DURING the conjunction of the planets Mercury and Venus, on September 30 last year, measurements of their relative power of light-reflection were made at Strasburg Observatory (we learn from *Astr. Nachr.*) by Herr Schnur. The half-objective of the telescope which showed Venus was gradually shaded by measurable quantities till equal surface-portions of Venus appeared of the same brightness as those of Mercury through the unshaded part. The measurements on September 30 gave for relative light intensity the value 6·75, and on October 2 the value 5·36; the latter figure is considered the more reliable, and may be accepted for the relative brightness of Mercury and Venus. Herr Zöllner, by a quite different method, got 5·5.

APPLICATIONS for the intended Exhibition of Applied Science in Paris may be sent to M. Nicolle, director, 10, rue de Lancry, Paris. The presidency of the Patronage Committee has been accepted by M. Jules Simon. More than 200 English firms have already sent in their adhesion, and more than 300 German firms wish to protest against the abstention imposed by their own Government in 1878. A large number of these belong to

Alsace-Lorraine. The exhibition will keep open from July 15 to the end of November, but a limit will be imposed on exhibitors sending in their applications.

ON April 27 an earthquake was felt at Florence, and also at Bologna. The Florence commotion was very slight, but had been preceded by other movements of a similar nature, which ought not to pass unnoticed, especially in connection with the seismic manifestations felt in Germany, as mentioned in our last impression.

MR. ROWLAND WARD writing to the *Standard*, states that in making the excavation at Charing Cross for Messrs. Drummonds' new bank, the workmen, at depths varying from fifteen to thirty feet, came upon the fossil remains of various extinct animals. They include elephant tusks and molars (probably the mammoth *Elephas primigenius*), teeth and numerous bones of the gigantic extinct ox (*Bos primigenius*), a portion of the horn of the great extinct Irish deer (*Megaceros hibernicus*), along with various other remains of ruminating animals not yet identified. The specimen in this series which has specially attracted notice is the extreme end of a tusk unusually sharp at the point and highly polished, and from a portion of the surface of which a very thin skin of ivory peels off, exposing a strongly and regularly longitudinally channelled surface beneath.

MR. WATSON LYALL'S "Sportsman's and Tourist's Guide" improves every year. It has now reached its seventh year, and is evidently a great success. The information as to shootings, rivers, lochs, &c., of Scotland is as full as could be, and is evidently kept well up to date. It deserves all the success it has obtained. In this connection we greatly regret to see that the disease which we referred to last year as having broken out among the Solway salmon has reappeared this year, not only in the Solway rivers, but in the Tweed. Mr. Sterling, of the Edinburgh Anatomical Museum, found it to be a branching fungus (*Saprolegnia ferax*), which, first attacking the scaleless parts, rapidly spreads over the whole fish. The disease has not yet appeared north of the Tweed. Sir Robert Christison recommends a Royal Commission, and the careful watching of all salmon and trout streams, whether affected or not.

WE are glad to see from its Twenty-first Report that the East Kent Natural History Society is fulfilling its functions, though under many disadvantages.

WE have already referred to the forthcoming annual meeting, at Leicester, of the Midland Union of Natural History Societies. Those interested in the meeting will find further details in our advertisement columns.

IN Prof. Jevons's article (vol. xix. p. 588), second column, line 18, for "a seer is equal to about 21 lb. avoirdupois," read "a seer is equal to about 2 lb. avoirdupois." The error is a purely typographical one, and does not affect any other statements in the article. Mr. E. H. Pringle asks us to state that in his letter (vol. xx. p. 6), "such distances as six," &c., should be "such heights as six," &c., and "mountain 20,000 feet high (less than 4 miles)" should be "mountain 10,000 feet high (less than 2 miles)." He thinks it may be worth mentioning that Raoul or Sunday Island, in the Kermadecs, has an elevation of 1,627 feet, commanding a sea horizon of nearly 50 miles radius.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mr. E. Brett; a Pig-tailed Monkey (*Macacus nemestrinus*), from Java, presented by Mr. E. M. Clissold; a Black-faced Spider Monkey (*Ateles ater*) from Eastern Peru, two Passerine Ground Doves (*Chamæpelia passerina*) from America, presented by Capt. H. King; an Ocelot (*Felis pardalis*) from America, presented by Mr. B. H. Jones; a Crab-eating Raccoon (*Procyon cancrivorus*) from South America, presented by Mr. Bridget; a Long-tailed Marmot (*Arctomys caudata*) from Bhootan, presented by Capt. Greenstreet, R.E.; a Silver Pheasant (*Euplocamus nycthemerus*) from China, presented by Mr. E. J. Beagle; a Small Hill Mynah (*Gracula religiosa*) from South India, presented by Mr. J. W. Wodler; five Water Ouzels (*Cinclus aquaticus*), British Isles, presented by Mr. F. Swabey; an Anaconda (*Eunectes murinus*) from South America, presented by Mr. G. H. Hawtayne, C.M.Z.S.; a Teguexin Lizard (*Teius teguexin*) from South America, a Leopard Tortoise (*Testudo pardalis*) from South Africa, purchased; a Tamandua Ant-eater (*Tamandua tetradactyla*) from South America, a Great American Egret (*Ardea egretta*) from America, deposited; a Reeves's Muntjac (*Cervulus reevesi*) born in the Gardens.

RECENT CONTRIBUTIONS TO THE HISTORY OF DETONATING AGENTS[1]

II.

THAT the power possessed by different very highly explosive substances, of inducing the detonation of such bodies as gun-cotton and nitro-glycerine, is not solely ascribable to the operation of mechanical force very suddenly developed, is indicated not only by the singular inertness of gun-cotton to the influence of nitro-glycerine as a detonating agent, but also by a comparison of the behaviour of other detonating substances with that of the mercuric fulminate, when applied to the detonation of gun-cotton. Thus the detonation of silver fulminate is very decidedly sharper than that of the mercury compound, yet it is in no way superior to the latter in its power as an initiative detonating agent; indeed, a somewhat larger amount of it appeared to be required than of the mercury salt to induce detonation of gun-cotton with certainty. Again, the iodide and chloride of nitrogen are far more susceptible of sudden detonation than the silver fulminate; yet while 5 grains of the latter, confined in a stout metal envelope, suffice to detonate gun-cotton, 50 grains of chloride of nitrogen confined by water, appeared to be the minimum amount with which the detonation of gun-cotton could be accomplished with certainty, while no success attended the employment of confined iodide of nitrogen in quantities ranging up to 100 grains.

The incompatibility of these results with the general conclusion, based upon numerous and greatly varied experiments, that the facility with which the detonation of gun-cotton and nitro-glycerine, and bodies of a similar character as explosives, is induced by an initiative detonation, is proportionate to the mechanical force aided by the heat developed by the latter, led the lecturer to the conclusion that a synchronism or similarity in character or quality of the vibrations developed by the detonation of particular substances, operates in favouring the detonation of one such substance by the initiative detonation of a small quantity of another, while in the absence of such synchronism, a much more powerful detonation, or the application of much greater force, would be needed to effect the detonation of the material operated upon. This view has received considerable support from results since obtained by other experimenters, especially by MM. Champion and Pellet; but the subject is one which still needs further experimental elucidation.

The physical character of explosive substances, as also the mechanical condition of a mass of the particular explosive substance operated on, are of great influence in determining its behaviour when submitted to the action of an initiative detonation. The liquid nitro-glycerine is far more sensitive to detonation than gun-cotton; one grain of mercuric fulminate, confined in a metal case, suffices to detonate nitro-glycerine when surrounded by it; but, in order to attain this result with any degree of certainty, it is necessary so to confine the nitro-glycerine as to prevent its yielding to the blow developed by the initiative detonation, and thus to some extent escaping from the operation of the sudden concussion to which the particles contiguous to the fulminate charge are submitted.

If nitro-glycerine be mixed with solid substances in a fine state of division, plastic mixtures may be obtained, and the liquid may thus be presented in something like a solid form to the

[1] Weekly Evening Lecture at the Royal Institution, Friday, March 21, 1879. By Professor Abel, C.B., F.R.S. Revised by the Author. Continued from p. 21.

detonating agent; if the particles of absorbent material be, moreover, of porous nature, as is the case with the infusorial earth called kieselguhr, used in the production of dynamite, a solid nitro-glycerine preparation may be obtained which contains a very large proportion of the liquid (75 per cent. by weight). In this condition nitro-glycerine may be detonated without any difficulty when freely exposed to air; and although it is diluted with a considerable proportion of absolutely inert material, its sensitiveness to detonation is not in the least diminished. Each particle of the diluent is enveloped in the liquid, so that no portion of the latter becomes isolated from the remainder by the admixture of inert solid matter; hence, when the initiative detonator is surrounded by such a mass, it is in contact at all points with some portion of the nitro-glycerine, and the latter is in continuous connection throughout, though no longer in a mobile condition; detonation is consequently as readily established and transmitted through the mass as though it consisted entirely of nitro-glycerine. Indeed, while the liquid in its undiluted state, if freely exposed to air in a long layer, transmits detonation with difficulty, and very slowly as compared with compressed gun-cotton (the observed rate of progression being, in several experiments, below 6,000 feet per second), detonation is transmitted with ease and certainty through very long trains of a solid preparation of nitro-glycerine, such as dynamite, and the rate of transmission is decidedly more rapid than it is with compressed gun-cotton, a result which is in harmony with the greater sensitiveness to detonation and the greater violence of action of nitro-glycerine.

It has already been stated that gun-cotton may be detonated if a confined charge of not less than two grains of mercuric fulminate be detonated when closely surrounded by the substance. But in order to attain this result, the cellulose-product must be presented to the detonating agent in a mechanical condition favourable to its action.

Gun-cotton in a loose flocculent condition, or even if in the more compact form of a spun yarn or thread, cannot be detonated through the agency of a large charge of fulminate buried in the material. It is simply scattered with violence, portions being sometimes inflamed by the heat developed where the fulminate is detonated. If however, the gun-cotton be converted into a compact form, either by ramming the wool or thread very tightly into a case, or better still, by reducing the gun-cotton fibre to a very fine state of division, and then compressing it into compact masses, it becomes susceptible of detonation by the initiative action of mercuric fulminate, and the quantity of the latter required to bring about detonation is small in proportion as the compactness or density of the compressed material is increased.

Detonation, when established in compressed gun-cotton, is transmitted with great velocity throughout the mass, as already stated, or from one to another of contiguous masses, and even, though at a reduced rate, if small spaces exist between the individual masses. But, if a small mass of compressed gun-cotton freely exposed to air be detonated when in immediate contact with gun-cotton wool or loosely-twisted yarn, the detonation will not be transmitted to these, but they will merely be scattered and perhaps inflamed.

The difference in the behaviour of nitro-glycerine and of gun-cotton when presented to the action of a so-called initiative detonation under the different conditions spoken of above, admits of ready explanation.

It has been thoroughly established that the action of an initiative detonation is not ascribable to the heat developed within the detonating material itself, in undergoing chemical metamorphosis. Its action has already been compared to that of a blow from a hammer or falling weight. The readiness and certainty with which gunpowder, gun-cotton, and other explosive agents are detonated by the latter agency are regulated by several circumstances; they are in direct proportion to the weight of the falling body, to the height of its fall, and to the force with which it is impelled downwards; to the velocity of its motion; to the mass and rigidity or hardness of the support upon which the substance to be detonated rests; lastly, to the quantity and mechanical condition of the explosive agent struck, and to its sensitiveness.

Gunpowder is much more readily detonated by a sharp blow from a small hammer than by the simple fall of a heavy hammer, or by a comparatively weak blow from the latter. It is very difficult by repeated blows, applied at very brief intervals, to detonate gun-cotton if placed upon a support of wood or lead, both of which materials yield to a blow, the force applied by that blow being transferred through the explosive agent and absorbed in work done upon the material composing the support. But if the latter be of iron, which does not yield permanently to the blow of the hammer, the detonation of those substances is easily accomplished. If the quantity of the explosive agent employed be so considerable as to form a thick layer between the hammer and support, the force applied is to so great an extent expended in imparting motion to the particles of the compressible mass, that there remains little or none by which its detonation can be accomplished, and if the material be in a loose or porous condition (as in the case of a powder or of loose wool), much work has to be accomplished in moving particles of the mass through a comparatively considerable space, in the operation of compressing them, so that a second or even a third blow is required for their detonation; whereas if, by blows or pressure previously applied, the explosive material will be presented in the form of a compact mass, the particles of which have little tendency to motion when force is applied to them, detonation will be much more readily developed. It appears, therefore, that the detonation of an explosive substance by means of a blow is the result of the development of heat sufficient to bring about most energetic chemical action, or change, by expenditure of force in the compression of the material, or by establishing violent friction between its particles, consequent upon the motion momentarily imparted to them, and that it is brought about with a readiness proportionate to the resistance which they oppose to their motion by the degree of their contiguity to each other.

The exceedingly violent motion of particles resulting from the sudden or extremely rapid transformation of a solid or liquid explosive body into highly heated gas or vapour (which is the effect of a detonation), must obviously exert force which operates upon a body opposed to it in a manner precisely similar to the force applied by opposing a body in the path of a solid mass which is set into very rapid motion. The power of accomplishing the detonation of nitro-glycerine, gun-cotton, or other highly explosive substances, freely exposed to the air, through the agency of detonation produced in their vicinity or in close contact with them, appears therefore correctly ascribable to the heat suddenly developed in some portion of the mass by the mechanical effect, or blow exerted by that detonation, and is regulated by the violence and suddenness (either singly or combined) of the detonation, by the extent to which the particles composing the mass of the explosive material are in a condition to oppose resistance to the force, and by the degree of sensitiveness of the substance to detonation, or to sudden metamorphosis, under the influence of heat thus developed.

It will now be evident why the readily yielding nature of the particles of liquid nitro-glycerine tends to counteract its great sensitiveness to detonation, and why, when the motion of the liquid particles is impeded by their admixture with solid matter, and when they are consequently placed in a position to resist mechanical motion by the force applied through the agency of detonation, its natural sensitiveness to detonation, and the rapidity with which it can be transmitted from particle to particle become fully developed.

Again, the reduction of gun-cotton fibre to a fine state of division, which renders the material readily convertible into very compact and dense masses, places the particles in the condition most favourable to resist mechanical motion upon the application of a blow, or of the concussion resulting from a detonation; hence, compressed gun-cotton is readily susceptible of detonation in proportion to the extent of compression, or to its density and compactness, while loose gun-cotton wool, or the lightly twisted or compressed material cannot be readily detonated, because the force applied is expended in imparting motion to the readily yielding particles of the mass. If the force applied through the agency of a detonator to a mass of explosive material just borders upon that required for the development of the detonation, or if the condition of the mass is such as hardly to present the requisite resistance to mechanical motion essential for its detonation, then, results intermediate between the mechanical dispersion of the mass and its violent chemical dispersion or disintegration, *i.e.*, detonation, are obtained. Thus, frequent instances have been observed, especially in the experiments in the transmission of detonation through tubes, in which the initiative detonation has brought about an explosion attended with little, if any, destructive effect, portions of the mass being at the same time dispersed and occasionally inflamed. Even silver fulminate, which under ordinary conditions detonates

violently, even when only a particle of the mass is subjected to a sufficient disturbing influence, has been exploded without the usual demonstrations of force, by the transmitted effect of a detonation of mercuric fulminate. In these instances the violence of the concussion produced by the initiative detonation was only just bordering on that required for the development of detonation, and it appears probable that only some small portion of the mass operated upon was in a condition or position favourable to the action of the initiative blow. The remainder of the mass would then be dispersed by the gases developed from the detonated portion; in some instances the particles would be inflamed at the moment of their dispersion, in others, they would even escape ignition.

Some experiments made in firing at masses of compressed gun-cotton, differently arranged and of different thicknesses, with a Martini-Henry rifle, at short ranges, afforded interesting confirmation of the correctness of the explanation given of the operation of a blow upon masses of explosive material under different conditions. Disks of gun-cotton of the same density and diameter, but differing in thickness, were fired at; they were freely suspended, and their distance from the marksman was in all instances 100 yards. The thinnest disks were simply perforated by the bullets; somewhat thicker disks were inflamed by the impact of the bullet, while still thicker disks, fired at under the same conditions, were exploded. No instance of detonation was, however, obtained. These differences in effect, obtained with masses of different thickness and weight, are due to the difference in their power to resist mechanical motion when struck by the bullet, and in the different amount of resistance to penetration presented by the thin and the thicker disks.

It has been explained that nitro-glycerine may be largely diluted with inert solid matters without its sensitiveness to detonation being reduced, while its detonation in open air becomes very much facilitated, because the tendency of its particles to yield to the force of a blow or detonation, is very greatly diminished. But if a *solid* explosive agent is diluted with inert *solid* matter the case is different; for in such a mixture of the finely divided solid with non-explosive solid particles, there must be a partial and sometimes a complete separation of the particles of the explosive by the interposed inert particles with which it is diluted; hence the sensitiveness to detonation is reduced, and its transmission by the particles is retarded or altogether impeded, by a diminution of the extent of contact between the substance to be detonated and the initiative detonation, and by the barrier which the interposed non-explosive particles oppose to the transmission of detonation. In experiments made in this direction with finely divided gun-cotton, it was found that although dilution with an inert solid, applied in the *solid form*, reduced the sensitiveness of the material to detonation, this was not the case when it was incorporated with a salt soluble in water, the mixture being then compressed while in the wet state. The compressed masses thus obtained were, when dried, in a condition of greater rigidity than could be attained by submitting undiluted gun-cotton to considerably more powerful pressure, because the crystallisation of the soluble salt used as the diluent upon evaporation of the water, cemented the particles composing the mass more rigidly together. The gun-cotton was therefore presented in a form more capable of resisting the mechanical action of a small charge of fulminate, than a more highly compressed undiluted gun-cotton, and hence the reduction in sensitiveness due to the detonation of the explosive compound is nearly counterbalanced by the greater rigidity imparted to the mass. If a soluble oxidising agent (a nitrate or chlorate) be employed as the diluting material, the predisposition to chemical reaction between it and the gun-cotton (which is susceptible of some additional oxidation), appears to operate in conjunction with the effect of the salt in imparting rigidity to the mixture, thus rendering the latter quite as sensitive to the detonating action of the minimum fulminate charge as undiluted gun-cotton. Moreover, the interesting fact has been conclusively established, that these compressed mixtures of gun-cotton with a nitrate or a chlorate are much less indifferent to the influence of detonating nitro-glycerine than gun-cotton in its pure state, chlorated and nitrated gun-cotton being detonated with certainty by means of ½ oz. of nitro-glycerine.

If compressed gun-cotton is diluted by impregnating the mass with a *liquid*, or with a solid which is introduced into the mass in a fused state, its susceptibility of detonation is reduced to a very much greater extent than by a corresponding quantity of a solid inert body, incorporated as such with the gun-cotton, the cause being the converse of that which operates in preventing a reduction of the sensitiveness to detonation of nitro-glycerine by its dilution with an inert solid. In this case the explosive liquid envelopes the solid diluent, and remains continuous throughout, occupying the spaces which exist between the solid particles; hence detonation is readily established and transmitted. But in the case of the solid explosive the diluent, which is liquid, or at any rate is introduced into the mass in the liquid state, envelopes each particle of the solid, so that a film of inert material surrounds each, isolating it from its neighbours, and thus opposing resistance to the transmission of detonation, which is proportionate to the original porosity or absorbent power of the mass.

While compressed gun-cotton, in the air-dry state, is detonated by 2 grains of mercuric fulminate imbedded in the material, its detonation by 15 grains, applied in the same manner, becomes doubtful when it contains 3 per cent. of water, over and above the 2 per cent. which exists normally in the air-dry substance. Specimens which had been impregnated with oil or soaked in melted fat and allowed to cool could not be detonated by means of 15 grains of fulminate. These diluted samples of gun-cotton could only be detonated by adding very considerably to the power of the initiative detonation; 100 grains of confined fulminate generally failed to detonate gun-cotton containing from 10 to 12 per cent. of water, and if the amount reached 17 per cent., 200 grains of fulminate were needed to insure its detonation.

But moist or wet compressed gun-cotton is decidedly more susceptible of detonation by (dry) compressed gun-cotton itself than by mercuric fulminate.

Thus 100 grains of dry gun-cotton, detonated through the agency of the ordinary fulminate fuze, suffice to detonate wet gun-cotton containing 17 per cent. of water, though this result is somewhat uncertain. If the diluting agent amounts to 20 per cent., detonation is not certain with less than 1 oz. of dry gun-cotton, and if the compressed material be completely saturated with water (*i.e.*, containing 30 to 35 per cent.), 4 oz. of the air-dry substance, applied in close contact, are needed to insure its detonation.

Detonation is transmitted through tubes from dry compressed gun-cotton to a moist disk of the material with the same facility as to the dry substance; and this is also the case with regard to the propagation of detonation from one mass of moist gun-cotton to another, in open air, all the pieces being ranged in a row, in contact with each other, provided that the piece first detonated does not contain less water than the others to which detonation is transmitted.

Gun-cotton containing 12 to 14 per cent. of water is ignited with much difficulty on applying a highly heated body. As it leaves the hydraulic press upon being converted from the pulped state to masses having about the density of water, it contains about 15 per cent. of water; in this condition it may be thrown on to a fire or held in a flame without exhibiting any tendency to burn; the masses may be perforated by means of a red-hot iron or with a drilling tool, and they may with perfect safety be cut into slices by means of saws revolving with great rapidity. If placed upon a fire and allowed to remain there, a feeble flame flickers over the surface of the wet gun-cotton from time to time as the exterior becomes sufficiently dry to inflame; and in this way a piece of compressed gun-cotton will burn away very gradually indeed. A pile of boxes containing in all 6 cwt. of gun-cotton, impregnated with about 20 per cent. of water, when surrounded by burning wood and shavings in a wooden building was very gradually consumed, the gun-cotton burning as already described when the surfaces of the masses became partially dried. Quantities of wet gun-cotton of 20 cwt. each, packed in one instance in a large, strong wooden case, and, in the other, in a number of strong packing cases, have been placed in small magazines, very substantially constructed of concrete and brickwork. Large fires were kindled around the packages in each building, the doors being just left ajar. The entire contents of both buildings had burned away, without anything approaching explosive action, in less than two hours. This comparatively great safety of wet gun-cotton, coupled with the fact that its detonation in that condition may be readily accomplished through the agency of a small quantity of dry gun-cotton, which, through the medium of a fulminate fuse or detonator, is made to act as the initiative detonating agent, gives to gun-cotton important advantages over other violent explosive agents for purposes which involve the employment of more or less considerable quantities

at one time, on account of the comparative safety attending its storage and the necessary manipulation of it. Moreover, it has been well established by experiments of many kinds carried out on a considerable scale, as well as by accurate scientific observations, that the detonation of wet gun-cotton is decidedly sharper or more violent than that of the dry material; a circumstance which affords an interesting illustration of the influence exerted by the physical condition of the mass upon the facility with which detonation is transmitted from particle to particle. In the determinations made by means of the Nobel chronoscope, of the velocity with which detonation is transmitted along layers or trains of gun-cotton and nitro-glycerine, the lecturer has included experiments with gun-cotton containing different proportions of water. When the material contained 15 per cent. of the liquid, some indications were obtained that the rate of transmission of detonation was a little higher than with dry gun-cotton; the difference was very decidedly in favour of wet gun-cotton, when the latter was thoroughly *saturated* with water. The air in the masses of compressed gun-cotton being replaced entirely by the comparatively incompressible body, water, the particles of explosive are in a much more favourable condition to resist displacement by the force of the detonation, and hence they are more readily susceptible of sudden chemical disintegration. Moreover, the variations in the rate of travel of detonation in dry gun-cotton, resulting from differences in the compactness or rigidity of different masses of the material, are very greatly reduced, if not entirely eliminated, by saturating the disks with water, and thus equalising their power of resisting motion by a sudden blow.

Another striking illustration of the influence which the physical character of an explosive substance exercises over its susceptibility to detonation and the degree of facility with which its full explosive force is developed, is furnished by one of the most recently devised, and one of the most interesting of existing, explosive agents.

Twelve years ago, soon after the process of producing compressed and granulated gun-cotton had been elaborated by the lecturer, it occurred to him to employ these forms of gun-cotton as vehicles for the application of nitro-glycerine. A considerable proportion of the liquid was absorbed by the porous masses of gun-cotton, and a nitro-glycerine preparation analogous in character to dynamite was thus obtained. The absorbent was in this case a violently explosive body instead of an inert solid as in dynamite, but the quantity of nitro-glycerine in a given weight of the preparation (to which the name of glyoxilin was given), was considerably less than in the kieselguhr-preparation; hence the latter was nearly on a point of equality with it, in regard to power, as an explosive agent.

(To be continued.)

NOTES FROM RUSSIA

GEOGRAPHY AND ANTHROPOLOGY.—At the last meeting, April 23, of the Imperial Russian Geographical Society, M. Sreznefsky, the Secretary, communicated his monthly report on the work of the Society. This consisted in equipping three expeditions in which the Society intends to take part, and its participation in the Anthropological Exhibition of Moscow. The first expedition is the cruise of the steamer *Nordenskjöld*, equipped by the well-known merchant of Siberia M. Sibiriakoff, for the relief of Prof. Nordenskjöld in the *Vega*. It will proceed from Malmö direct to Yokohama, Behring Strait, and beyond. According to the request of M. Sibiriakoff the Society appointed to accompany the expedition M. A. W. Grigorieff, an accomplished botanist, known for his dredging work in the White Sea, where he collected very interesting specimens of marine fauna with deep soundings and temperature observations, by means of a Negretti and Zambra deep-sea thermometer. He proceeds to Malmö to join the expedition, with a Dent chronometer from the Society, and a complete provision for zoological collections, and a sufficient provision of alcohol.

The second expedition is sent out by the Ministry of Public Works, for the exploration of the old bed of the Amu-daria (Usboi), and to investigate the possibility of turning the river to the Caspian; it will be under the direction of Major-General A. T. Gloukhofskoi, an experienced traveller in Central Asia. The Society sends two Fellows with the expedition, a geologist, Prince Sedroiz, and the economist, N. A. Majef, the manager of the *Turkestan News*, a collector of varied statistical materials in Turkestan. The third expedition, of a private character, is to explore for a railroad from Orenburg to Tashkent, and the possibility of navigating with steamers the Sir and Amu-daria. By order of the Emperor a sum of 5,000 roubles is placed at the disposal of the Society.

The Anthropological Exhibition was opened in Moscow on April 15, under the superintendance of the Society, which has sent a great number of valuable objects of an ethnological character, with craniological collections and prehistorical specimens, tumuli excavations, and a valuable collection belonging to the Czarevich. All these collections were arranged by M. Sreznefsky, the Secretary of the Society, who was sent as its representative to the opening of the exhibition. The aim of this exhibition is: (1) To contribute to the development of anthropology as a science. (2) The foundation of an anthropological museum for the teaching of anthropology in the University of Moscow. (3) To popularise the science.

The exhibition is divided into sections—prehistorical, anthropological, medico-anthropological, photographical, ethnographical, the history of Russian types.

At the end of the meeting of the Society M. Alenitzin communicated his paper on the history of the Amu-daria question; he criticised the different opinions on the possibility of turning the Amu-daria into the Caspian, and doubted whether this question could be resolved practically and in a positive manner.

A. LOMONOSSOFF

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Council of the Society of Arts having received an application from the City and Guilds of London Institute for the Advancement of Technical Education, offering to take charge of the technological examinations established by this Society in 1873, and carried on to the present time, have resolved to transfer these examinations to the charge of the Institute. The Council have also ascertained that the Science and Art Department will assist the City Institute in conducting the examinations, in the same way as it has hitherto assisted the Society of Arts. The technological examinations for the present year will, therefore, be carried on under the direction of the Institute, and all communications on the subject should be addressed to the Hon. Secretaries, City and Guilds of London Institute, Mercer's Hall, E.C.

THE following is the result of the recent examination for the Public Schools Prize Medals of the Royal Geographical Society: Physical Geography (examiner John Ball, F.R.S.), gold medal, Matthew George Grant; silver medal Frank Taylor Sharpe, both of Liverpool College. Honourably mentioned: E. G. Harmer, University College School; H. Ll. Smith, Bristol Grammar School; F. S. Carey, Bristol Grammar School; A. T. MacConkey, Liverpool College. Political Geography (examiner Canon Tristram, F.R.S.), gold medal, David Bowie, Dulwich College. Silver medal, Claude L. Bickwell, Harrow School. Honourably mentioned, J. F. Naylor, Dulwich College; W. H. D. Boyle, Eton; A. D. Rigby, Liverpool College; Theod. Brooks, London International College; R. A. Fawcett and A. C. Painter, of Clifton College.

ON May 1 an interesting ceremony took place at St. Barbe, the principal free institution at Paris. Two bodies of pupils were marched under the direction of teachers; the first was going to the Gare du Nord in order to come to London and spend six months in a corresponding English institution to learn the English language; the other went to the Gare de l'Est to proceed to Germany. These pupils have already learned foreign languages in Paris. They are placed under the supervision of professors, so that the usual routine of their studies for French honours should not be interrupted in any way.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 3.—In view of contradictory results got by Sir W. Thomson and M. Le Roux, with regard to the thermo-electric behaviour of stretched wires, Herr Cohn has made a number of experiments, here described in an inaugural dissertation. He finds that the intensity of the thermo-current between stretched and unstretched wire of the same metal, depends (apart from all *permanent* properties), not only on the present tension of the former, but also, in very different

degree according to the material used, on the upper and lower limits between which, since the last complete release from tension, the tensions have varied (the *succession* alone, not the *time*, being here determinant). In a thermo element of two similar wires, stretched with equal weights, but of which one (a) has last borne a greater, the other (b) a less weight, the current flows from b to a. In iron and steel the previous tensions even affect the direction in which the thermo-current varies with increasing or decreasing tension. Taking the direction of the current which arises with the *first* weak stretching, it is opposite for hard and soft wires, and the discordance above referred to is thus explained. Herr Cohn thus formulates his general conclusion: "A stretched wire behaves, *ceteris paribus*, differently, according as it has before been stretched more weakly or more strongly, and this difference continues till the next alteration of the tension."—Herr R. Weber contributes a useful paper on the chemical composition of glasses with relation to their resistance to atmospheric influences. He finds that the composition of many well tested lime alkali glasses approximates the proportions $6SiO_2$, $1CaO$, and $1K_2O$ or Na_2O; but also, in good glasses, there may be more alkali, if it be compensated with more than 6 equivalents of silicic acid; and less silicic acid may be allowed if the lime be diminished relatively to the alkali.—The transmission of high tones through the telephone is discussed by Herr Hagenbach. From his experiments it appears that the (upper) limit of audibility with the instrument is commonly about two octaves lower than in direct hearing. The cause is found not in the line, nor in the magnet, but in the plate, which, when the variations of magnetism exceed a certain number per second, no longer keeps up with them.—Herr Aron gives a mathematical study of the microphone; *inter alia*, it is shown that, whereas in the telephone the "clang tint" is exalted, in the microphone it is lowered.—Herr Herwig prosecutes his study of liquid cells as condensers; considering the charge of cells, first by large constant batteries, then by small forces (both acting shortly), and comparing the full charges in cells containing liquids of different resistances.—We further note a new hygrometer by Herr Edelmann, based on the fact that if any space be filled with atmospheric air, and the aqueous vapour then removed, without altering the volume, the pressure decreases by the amount of tension of this vapour. A sinus manometer for measuring small differences of air-pressure (Thomsen), and a simple regulator for the electric light (Stöhrer) are also described.—Herr Fröhlich shows the bearing of the principle of conservation of energy on the theory of diffraction.

THE *Rivista Scientifico-Industriale*, (1879, No. 7) contains the following papers of interest:—On some prehistoric discoveries in Sicily, by Prof. Francesco Mangini.—On the lengthening of filiform conductors traversed by an electric current, by Prof. G. Basso.—On the optic rotatory power of quartz and its variation with temperature, by M. Joubert.—On digallic acid, by Prof. U. Schiff.—On some phenomena due to the viscosity of liquids, by Prof. Carlo Marangoni.—On Sargasso seas, by the same.—On Helmholtz' double siren, by the editor.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 20 and 27, and April 3.—"On the Reversal of the Lines of Metallic Vapours," Nos. iv., v., and vi., by Professors Liveing and Dewar.

In the first of these experiments the metals were produced by chemical reactions within the tubes, used as before described. They found that cæsium chloride alone heated in glass tubes gave no absorption lines, but cæsium and rubidium chlorides when heated with metallic lithium each showed its characteristic absorption lines. Charred tartrate of cæsium heated in a furnace in a narrow porcelain tube gave very readily the two lines in the blue reversed, and charred rubidium tartrate the two violet lines reversed, but no reversal in any other part of the spectrum. When charred potassium tartrate was treated in the same way, a broad absorption band was seen extending from wave-length about 5,700 to about 5,775. This band was also seen for a short time bright, when the material was put into the tube before it was heated, and the light observed as the tube got hot. It was also seen bright in the induction-spark taken between platinum and potassium in carbonic oxide. Besides this band the vapours from the charred potassium tartrate produced another absorption band in the red, and two more in the blue. None of these absorptions correspond with those seen when potassium is heated in hydrogen, or with known emission lines of that metal, though the first and most conspicuous is near a well-known group of three bright lines of potassium. Charred sugar mixed with carbonate of soda gave only the same absorption as sodium in hydrogen. A mixture of barium carbonate, lamp-black, and aluminium filings gave dark bands corresponding to the bright bands seen when sparks are taken from a solution of barium chloride marked α, β, and δ respectively by Boisbaudran; and at the highest temperature of the furnace fed with Welsh coal a mixture of charred barium tartrate and aluminium gave the barium line wave-length 5535 sharply reversed. Charred strontium and calcium tartrates with aluminium gave no reversals, but with the addition of sodium or potassium carbonate the well-known blue line of strontium and violet line of calcium were reversed. The temperature at which these results were obtained was reached by the use of gas retort carbon as fuel, and was such that iron tubes well coated with fire-clay gave way in a few minutes.

The next experiments were made with tubes bored out of lime and heated at the bottom by a jet of coal-gas and oxygen introduced through a lateral opening. In these, as in the previous experiments, the hot bottom of the tube itself (not an independent light as used by Messrs. Lockyer and Roberts in their experiments with lime tubes) gave the luminous background. In this way the violet line of calcium was reversed, the red line of lithium and the orange and green bands of lime appeared with dark lines down their middles.

A larger series of experiments was made with similar tubes of lime, but with an electric arc introduced through lateral openings as the source of light and heat. In some cases a tube bored in a block of gas carbon was employed, and was then made one of the electrodes. The carbon tubes, however, were found to conduct away the heat, and though they lasted much longer, did not in general succeed so well as the lime tubes. In same cases aluminium was used as a reducing agent, and in others more volatile substances, viz., potassium and sodium carbonates, were used to increase the amount of vapour carried up into the tube; and in others a current of hydrogen was introduced.

Of the calcium lines the violet line (4226) was almost always seen expanded with a dark middle, and the three brightest lines in the indigo were often in a similar condition. The addition of aluminium generally made them appear as dark bands on a continuous background. Of the two Fraunhofer lines H, the more refrangible (K) was the first to appear reversed, and remained so the longer. Other calcium lines reversed were, one in the green (5188), and, much less easily, two in the red (6161, 6121), one more in the indigo (4302), and one in the blue (4877).

In the case of strontium, the well-known blue line was easily reversed, and two lines in the violet (4215, 4077), less easily five lines in the blue (4812, 4831, 4868, 4873, 4895), and, by the aid of aluminium, one in the green (4962). In the case of barium, besides the persistent ray 5535, two other lines in the green (5518, 4933), a line in the blue (4553), and one in the orange (6496), were reversed.

With magnesium the b group were expanded and reversed in an order the inverse of their refrangibility. The other lines of that metal were expanded, but not reversed, and the blue line, 4481, conspicuous in the spark between magnesium electrodes, was not seen at all. This line does not appear in Capron's photographs of magnesium in arc. An attempt to re-introduce it by combining the action of an induction spark with that of the arc in a lime tube failed owing to the conducting power of the hot gases and walls of the tube, and will probably only succeed with a pressure of several atmospheres in the apparatus. The similar disappearance of the cadmium lines 5377 and 5336 was also noticed.

In using potassium carbonate the two extreme pairs of lines, in the violet and red respectively, were readily reversed; less readily the three lines in the greenish-yellow, other two lines in the red (6913, 6946), a group of three in the orange (5353, 5338, 5322), and the least refrangible (5112) of another triplet in the green.

Using sodium chloride, the pair of lines next more refrangible than D were repeatedly reversed, the less refrangible being the first and most strongly reversed, as has also been observed by Mr. Lockyer. A second pair of bright lines usually came out at the same time, like ghosts of the first, on the more refrangible side.

With lithium chloride, the red and blue lines were easily re-

versed, the orange line well reversed, and the green, though with difficulty, distinctly reversed; the violet line, much expanded, showed no reversal. The authors conclude that the green line really belongs to lithium, and not to cæsium, since the blue lines of the latter metal, so easily reversed, never appeared.

In the case of rubidium, the more refrangible of the red lines was seen as a black line on a continuous background, but this background of light did not extend so low as to allow the reversal of the extreme ray of rubidium to be observed.

With metallic indium the two characteristic lines were seen strongly reversed, but no other; metallic gallium also gave its two characteristic lines reversed, the more refrangible being the less strongly so.

Aluminium gave no reversal of any of its lines, except the two between the Fraunhofer lines H. It was noticed that the addition of aluminium to either copper or silver in the lime tubes caused the copper or silver lines, previously predominant, to fade, while the calcium lines came out instead with marked brilliance.

Reviewing the series of reversals which they have observed, the authors remark that in many cases the least refrangible of two lines near together is the most easily reversed, as has been previously remarked by Cornu. Thus, in the case of barium (though there is no very distinct grouping of the lines of that metal), taking the rays in order, the line wave-length 5535 is readily reversed, while that with wave-length 5518 is less easily reversed; the line wave-length 4933 is comparatively easily reversed, whereas that with wave-length 4899 has not been reversed. On the other hand, the line wave-length 4553 has been reversed, but not the line wave-length 4524. In the case of strontium, the lines wave-length 4831 and 4812 have been reversed, but not the line wave-length 4784, and the two lines wave-length 4741 and 4721 remain both unreversed. In the group of five lines of calcium, wave-length 4318 to 4282, it is only the middle line wave-length 4302 which has been reversed. Of the potassium groups of lines wave-length 5829 and 5811, 5802, 5782, the line wave-length 5811 has not been reversed, and of the others the line wave-length 5802 is the first to appear reversed. It is worthy of remark that the first of these lines is faint and the last is the brightest of the group. The group wave-length 5353, 5338, 5322 have been all reversed, but the last of the three (5322) was the most difficult to reverse: it is also the feeblest of the group. In the more refrangible group, wave-length 5112, 5092, 5078, the least refrangible is the only one reversed.

Making a general summary of their results respecting the alkaline earth metals, potassium and sodium, and having regard only to the most characteristic rays, which for barium they reckon as 21 in number, for strontium 34, for calcium 37, for potassium 31, and for sodium 12, the reversals in their experiments number respectively 6, 10, 11, 13, and 4. That is in the case of the alkaline earth metals about one-third, and these chiefly in the more refrangible third of the visible spectrum; the number of characteristic rays remaining unreversed in the more refrangible part of the spectrum being respectively 2, 5, and 4. In the case of potassium they reversed two in the upper third, all the rest in the least refrangible third. These experiments relate to mixtures of salts of these metals combined with the action of reducing agents.

In a table the authors show the relation between their observations on reversals and Young's on the chromospheric lines.

The authors point out that in Young's catalogue the green coronal line (wave-length 5316) is almost as frequently present in the chromosphere as the lines numbered 1 and 82, and D_3 which he suggested might belong to one substance, and they think that the four lines may all belong to the same substance; and they call attention to certain analogies in the ratios of the wave-lengths of these four lines to those of the lines of hydrogen, lithium, and magnesium.

April 24.—"On the Nature of the Fur on the Tongue," by Henry Trentham Butlin, F.R.C.S.

Tongue-fur consists chiefly of (1) *Débris* of food and bubbles of mucus and saliva. (2) Epithelium. (3) Masses which appear at first to consist of granular matter, but which are the glœa of certain forms of schistomycetes. That the last-named of these three is the essential constituent is proved by the fact that the quantitity of the glœa corresponds roughly with the quantity of fur present, and that its position upon the tongue corresponds exactly with that of the fur, both covering the tops of the filiform papillæ, but not usually lying between them.

In order to ascertain the true nature of the glœa, and to obtain it in a purer form, it was cultivated upon a warm stage. Several fungi were discovered, but only two of these were present in every instance, *Micrococcus* and *Bacillus subtilis*; and, as the glœa produced artificially was similar to that existing naturally in the tongue-fur, it is believed that fur is composed essentially of these two fungi. *Micrococcus* developed freely and abundantly, forming large masses of yellow or brownish-yellow colour. *Bacillus* did not develop, but existed in greater or less abundance in all the cases examined. Its development was probably prevented by the presence of other developing organisms, from which it was found impossible to separate it. It appeared to be identical with the *Leptothrix buccalis* of Robin. Although it did not develop under artificial conditions, it is probable that development takes place freely upon the surface of the tongue. Its habitual occurrence there, and the presence of spore-bearing filaments favour this view.

Besides these fungi there were present, more or less constantly, *Bacterium termo*, *Sarcina ventriculi*, *Spirochæta plicatilis*, and a larger form of *Spirillum* (or rather *Vibrio*). *Sarcina ventriculi* was frequently present, and generally developed quickly, forming large masses of a yellow or yellowish-brown colour. *Spirochæta plicatilis* occurred only in two or three of the specimens examined. *Bacterium termo* existed in some of the furs, and twice developed with such rapidity that the whole of the fluid was crowded with these organisms.

The slime between and around the teeth was found to consist of the same fungi as the tongue-fur, but the rods of Bacillus were longer, probably owing to the disturbing causes being fewer.

Physical Society, April 26.—Prof. W. G. Adams in the chair.—Mr. C. V. Boys gave an account of some experiments made by Dr. Guthrie and himself on the subject of Arago's rotation. The experiments were begun with a view to determine if the drag on a copper disk when a magnet is made to revolve beneath it, or on the magnet if the disk is made to revolve above it, could be made use of for determining the velocity of running machinery. They made the magnet revolve, and obtained the angle of deflection of a disk suspended by a torsion thread (the hair-spring of a watch). They found, as Snow, Harris, and others found before, that other things being equal, the drag is directly proportional to the speed, so that if the torsion of the thread could be relied on, and the strength of the magnet did not change, a perfect velocimeter could be constructed. They consider that this method is better than observing the deflection of a magnet over a revolving disk, as in this case they are limited to less than a right angle, and changes in the absolute magnetism of the earth would affect the results. They also determined the effect of change of distance, thickness, diameter, and nature of the disk, &c., their results agreeing with those of former experiments. They observed that the effect of concentric circular cuts was far greater than that of even many radial cuts, and that when radial sectors were entirely separated from each other, the effect was much less than when these were united at the centre. They then experimented on liquids by suspending a sphere or cylinder of the liquid between the poles of a revolving electromagnet, and succeeded in getting a decided and measurable effect. The importance of this is very great, for they have thus a means of determining the conductivity of liquid electrolytes by currents induced in the liquid without the use of electrodes, and without polarisation.—Dr. Guthrie stated that as the push on the liquid is directly proportional to the current quantity, they hope to measure the conductivities of liquids, and connect these to the conductivity of solids through the intervention of mercury. In reply to Prof. Adams Mr. Boys said that the angle of deflection of the conductor had proved to be proportional to its conductivity. Dr. O. J. Lodge suggested that the conductivity of the disks used in these experiments should be determined by plotting out the equipotential surfaces. Dr. Sylvanus Thomson recommended trying conducting jellies in these experiments, and Dr. Guthrie replied that such were being prepared for trial, including the permanent jelly made by dissolving gelatine in anhydrous glycerine at 100°.—Prof. Sylvanus Thomson then communicated five laboratory notes from University College, Bristol. The first related to the source of sound in the Bell telephone receiver. Two theories are now being discussed as to this effect, the molar theory regards the motion of the diaphragm-mass as the source of sound, the molecular theory finds it in the molecular motions of the mag-

netic core of the instrument. Prof. Thomson applied his method of getting magnetic curves with iron filings dusted on gummed glass to this problem. He found that when no currents passed in the telephone the magnetic lines springing from the pole of the magnet are gathered together on the diaphragm opposite over a central region, which is magnetised lamellarly or like a magnetic shell. The rim of the plate beyond this region is, however, magnetised radially, and between these two zones there is a neutral circle. It was remarkable too that the lines of force touching the plate were bent back around this circle, forming a kind of valley. When the current passed in the coil, in a direction so as to reinforce the magnetism, the lines are gathered more closely on the central region of the plate. If the current diminishes the magnetism the lines are, on the other hand, repelled from the plate. The neutral ring is also altered. In the first case it shrinks in size, in the second it expands. A small thick disk is wholly magnetised lamellarly; a disk entirely magnetised radially becomes slightly conical in shape. In the actual telephone the disk is flat at the middle and conical at the edges. As the current varies the diaphragm will assume new nodal lines. Dr. Thompson concludes that the molecular theory is not therefore necessary to account for the speech of the telephone, although it may assist. As confirming this view, he found that with iron rings round a cardboard diaphragm, and an iron centrepiece, the enunciation was good, though the timbre was altered, whereas with radial pieces of iron on the cardboard, the timbre was good but the enunciation bad. In reply to Prof. Adams, Dr. Thompson said that the stronger the magnet the shorter the lamellarly magnetised space became, and that with a thicker disk the neutral ring was not so well marked. Dr. Lodge suggested that the best place for the coil would be in the valley over the neutral ring, which was in an unstable condition. Dr. Thompson next wrote on a saw-blade with a magnet and dusted iron filings on it, which arranged themselves so as to trace the writing. This is usually shown on a steel plate, but a saw retains the virtue for six or eight months. A modification of this experiment, due to himself, consisted in writing on the blade with one pole of a powerful battery, the other pole being connected to the end of the blade. The third "note" recommended the use of fine steel fibres, got by breaking iron gauze of 32 meshes to the inch, instead of iron filings, for exhibiting magnetic lines. The fourth note showed that the lines of force got by filings fixed on cards are magnetic, that of a bar-magnet acting as a magnet. The fifth note explained that solid magnetic "figures" could be got by coating iron filings in shellac to make them light, and floating them in water; or by mixing filings in a soft paste of plaster of Paris, which could be cut into sections on hardening.

Chemical Society, May 1.—Dr. Warren de la Rue, president, in the chair.—The following papers were read:—On the volumes of liquids at their boiling-points obtainable from unit volumes of their gases, by Dr. W. Ramsay. The author has suggested the use of a thin glass bulb filled with the liquid, and heated in its own vapour until expansion ceases, the bulb is then allowed to cool, and is weighed; thus the volumes of many liquids at their boiling-points, "ebullition volumes," has been determined by the author. His results agree closely with those obtained by Kopp; the time required for a determination is half an hour.—On a method of precipitating manganese as dioxide, and its application to the volumetric determination of manganese, by J. Pattinson. Manganese in solution can be completely precipitated as dioxide by bleaching-powder solution or bromine water, if an equal quantity of iron, as ferric chloride, be present. The dioxide is then dissolved in dilute sulphuric acid, reduced by standard ferrous sulphate and titrated with bichromate.—On the determination of nitric acid as nitric oxide by means of its action on mercury, by R. Warington. In this well-known process of Crum and Frankland the author has found that the removal of the chlorides is unnecessary, and that small quantities of organic matter, except cane sugar, do not interfere with the results.—On a new class of colouring-matters, by Dr. O. N. Witt. By oxidising a mixture of metatoluylene diamine and dimethylparaphenylendiamin in aqueous solution, the author has obtained several new colouring-matters, toluylen blue, violet, pink, &c.

Institution of Civil Engineers, April 29.—Mr. Bateman, F.R.S., president, in the chair.—The first paper read was on street carriageway pavements, by Mr. George F. Deacon, M. Inst. C.E.—The second paper read was on wood as a paving material under heavy traffic, by Mr. O. H. Howorth, Assoc. Inst. C.E.

EDINBURGH

Royal Society, April 21.—On the anatomy of the northern Beluga (*B. catodon*) compared with that of other whales, by Morrison Watson, M.D., and Alfred H. Young, M.B., of the Owens College, Manchester.—This paper contains a complete account of the visceral anatomy of *Beluga*. In connection with the larynx, the existence of pouches similar to those previously described by Murie in Risso's Grampus is pointed out. These pouches undoubtedly correspond to the large laryngeal air-sac of the whalebone whales; both are regarded by the authors as homologous with the ventricles of Morgagni of other mammals, and not, as considered by previous anatomists, with the well-marked air-sacs met with in several species of quadrumana.

BOSTON, U.S.A.

American Academy of Arts and Sciences, April 9.—Hon. Charles Francis Adams in the chair.—Prof. Benjamin Peirce presented a paper on the meteoric constitution of the solar system, in which the existence of a meteoric shell outside of the planetary system is maintained. The meteors, in falling from this shell, would be subject only to the attractions of the sun and planets. The motions of the larger meteors or comets were discussed, and some remarkable agreements of observed facts with the theory were shown.—Prof. Pickering described a new form of transit instrument for measuring the light of the stars. Much of the time spent when using other photometers in identifying the object is thus saved. The stars are compared directly with the pole-star, and the variations of an artificial star are thus avoided. At the Harvard College Observatory the measurement of the light of about 4,000 stars of the sixth magnitude and highest, has been undertaken with this instrument. Each star will be observed on three nights, and two sittings will be made each evening.—A paper on the action of bromine on substituted toluols was presented by Prof. C. Loring Jackson and Mr. A. W. Fields.—Mr. W. W. Jacques, of Johns Hopkins University, Baltimore, presented the results of an investigation into the distribution of heat in the spectra of various sources of radiation. The distribution of heat in the spectrum of a solid or liquid source of radiation was found to be nearly independent of the temperature of the source. Dr. Draper's conclusion that "It necessarily follows that in the spectrum any two equivalent series of undulations will have the same heating power, no matter what their actual wave-length may be," was found to be not correct.

CONTENTS

THURSDAY, MAY 15, 1879

THE VICTORIA UNIVERSITY

THE movement for founding a new university in the north of England has progressed considerably since the question was discussed in these columns in July, 1876. It has now shaped itself into a final memorial to the Privy Council, which will be presented to the Lord President by a peculiarly powerful deputation this very day. Let us hope that the reply will be a favourable one, believing as we do that the educational welfare of the country demands an increase in the number of its universities. It may be desirable to say a few words about the progress of this movement.

On July 20, 1877, a memorial addressed to the Privy Council was presented to the Lord President praying that Her Majesty should be advised to grant a charter to the Owens College, Manchester, to be thenceforth called the University of Manchester, with power to grant degrees in Arts, Science, Medicine, and Law.

A slight modification of the original programme has now been made with the view of providing more effectually for two of the objects contemplated in the former memorial, viz. (1) for an ample and sufficient control over the proposed university, as a national place of education and learning, by the Government of the country; and (2) for the incorporation in the proposed university, on equitable terms and on satisfactory conditions, of other colleges besides the Owens College. This is not the place in which to discuss in detail the constitution proposed. We may, however, remark that Owens College is to be named in the charter as the first college of the new university, and that Manchester is to be the local centre of this institution.

In consequence of this modification the support to the memorial will be, we believe, even more powerful than that formerly given and may be taken as fairly representing the opinion of two great counties in the north of England. The Lord President has consented to receive simultaneously two deputations, one headed by the Duke of Devonshire, president of the Owens College, and the other from the Yorkshire College, Leeds, headed by the Archbishop of York.

Since this scheme has been before the public the most persistent objection urged against it has been advanced by those who maintain that the teaching and examining functions of a university should be perfectly distinct. It may be worth while to discuss this objection from two points of view, endeavouring to ascertain in the first place what is the present practice in this country of the existing universities, and then to find what course is best in principle.

Let us begin with the London Examining Board, which has no teaching staff connected with it, and ask ourselves whether its machinery secures an absolute separation between the examining and teaching elements. There can only be a negative reply to this question. The Senate of the London Board frequently select examiners who are teachers in one of the two London colleges or in Owens College, Manchester; that is to say, in institutions which send numerous candidates to the London examinations.

The result of this system must inevitably be that (without any blame being attributable to any one) the pupils of such an examiner have an advantage over other candidates whose teachers are not so represented. Thus, with respect to this Central Board, only a partial separation between the teaching and examining elements has been found practicable, and a very questionable advantage has been given to certain candidates in the examinations.

Let us next take Cambridge, as representing one of the great English Universities. Here it is the practice that the Committees who arrange the branches of study for the various examinations should consist very largely of professors and lecturers, who likewise form a large portion of the examining body. Occasionally a private tutor is chosen as an examiner, in which case, for a few months preceding the examination, he is expected or required to give up those of his pupils who are coming forward as candidates.

Now, while this system is infinitely preferable to that of the London Board, yet even here the former pupils of the private tutors who have been chosen examiners must, we think, have a small advantage over the others, which is, however, reduced to a minimum inasmuch as the Boards of Examiners for a subject consist of four men at least. In the Queen's Colleges, Ireland, the practice is different. Here there are four colleges, which form together one University, and it is, we believe, the custom that, in conducting examinations for degrees in any college, the professors of that college should associate with themselves an outside element consisting of certain professors from the other colleges of the same University.

The practice in Scotland is somewhat similar to that in Ireland, the chief difference being that, whereas in Ireland the external element consists, we believe, of members of the teaching staff of one of the other colleges, in Scotland it consists of graduates of some one of the Scotch universities who are not engaged in university teaching in Scotland. Should the Victoria University succeed in obtaining a charter, its practice will be very similar to that in Scotland, and it must, we think, be owned that one advantage of this system is that by it all candidates are placed upon precisely the same footing.

All this, however, might be freely allowed by those who advocate an entire separation between teachers and examiners. They might reply that any such advantage is more than overborne by the manifest tendency to lower the standard of efficiency when the teacher is permitted to take any part in the examination of his pupils.

This subject has been very fully discussed in a recent report of the Royal Commissioners appointed to inquire into the universities of Scotland, one of whom was the well-known author of the "herring-brand" comparison. The following is a quotation from this report (page 49).

"The examination of the students of a university for their degrees by the Professors who have taught them, is sometimes spoken of as an obvious mistake, if not abuse: but those who are practically acquainted with university work will probably agree with us that the converse proposition is nearer the truth. In fact, it is hard to conceive that an examination in any of the higher and more extensive departments of literature or science can be conducted with fairness to the student, unless the examiners are guided by that intimate acquaintance with the extent and the method of the teaching to which the learner has had access, which is possessed only by the

teachers themselves. . . . The admirable influence which the Scottish universities have hitherto exerted upon the people of the country has been due not only to the prolonged and systematic course of mental discipline to which their students have been subjected, but to the stimulus and encouragement given to inquiring minds by distinguished men who have made the professorial chairs centres of intellectual life; and we cannot think it desirable that any such changes should be made as would tend to lower the universities into mere preparatory schools for some central examining board."

We are gratified to think that the sentiments which we expressed in these columns nearly three years ago should have received the sanction of such high authorities. As the subject is one of great importance, our readers will perhaps allow us to repeat the objections we then raised to the establishment of a Central Examining Board (see NATURE, vol. xiv. p. 255):—

"The Calendar of the Central Board must inevitably embody only the best-known and most widely-diffused results of knowledge—not that which is growing and plastic, but that which has already grown and hardened into shape—the knowledge, in fact, of a past generation which has become sufficiently well established to be worthy of this species of canonisation. A very powerful inducement is thus offered to the professors of the various colleges to teach their pupils according to this syllabus, and a very powerful discouragement to attempt to alter it. They may be men of great originality and well qualified to extend and amend their respective spheres of knowledge, but they have no inducement to do so. . . . . It is the old and time-honoured custom of killing off the righteous man of the present age in order the more effectually to garnish the sepulchres of his predecessors. Our readers are well aware that the natural philosophy course has changed its character very greatly of late years, and that for this we are much indebted to Professors Sir W. Thomson and P. Guthrie Tait. But could these men have done this under the system of a Central Board? If they had succeeded it must have been, as Galileo succeeded, against the attempt made by the ruling authorities of his day to stop his voice and strangle his originality."

It has always been a source of infinite amazement to us that a single man of eminence should come forward to advocate the gigantic apparatus for cram implied in a Central Examining Board.

May the day be far distant when the rising generation shall all be required to feed upon such rations! One is tempted to think that the advocate of this system must surely have suffered a transmutation similar to that which overtook Bottom, who, in consequence, entertained quite original notions on the subject of food. "I could munch," said that worthy, "your good dry oats. Methinks I have a great desire to a bottle of hay; good hay, sweet hay, hath no fellow."

ORGANISMS IN THE BLOOD, AND THE GERM THEORY

The Microscopic Organisms found in the Blood of Man and Animals, and their Relations to Disease. By Timothy Richards Lewis, M.B., Army Medical Department, Special Assistant to the Sanitary Commissioner with the Government of India. (Calcutta, 1879.)

WE have here in a small illustrated work an able critical *résumé* of some of the most important facts previously known on the subject together with others not hitherto published, tending not only to increase our knowledge, but also to throw light upon the general question of the relations of the microscopic organisms found in the blood to disease.

Nearly two-thirds of the work refers to the existence in the blood of vegetal organisms of the type of Bacteria, Bacillus, and their allies, while the remaining third relates to the existence in this situation of animal organisms. We have in this latter part a brief but interesting history of what is known concerning the existence of Nematoid hematozoa in the lower animals, and also of what has been learned concerning the embryos of the *Filaria sanguinis-hominis*, first discovered by the author in 1872, in the blood of persons suffering from Chyluria.

It seems evident from the account here given that we have still almost everything to learn as to the source and parental forms of these embryo Nematoids found in the blood of man. The hypothesis of Manson concerning the part played by mosquitos as intermediate hosts (within which some of the embryos swallowed may undergo development, and from the bodies of which parent-forms, capable of infecting man, may find their way into drinking water) seems, from the careful observations made by Lewis, to be rendered more than doubtful. The relations of these organisms to the morbid conditions with which they are associated are, indeed, full of the most puzzling difficulties. It is somewhat doubtful whether the mature form of this helminth has yet been discovered, notwithstanding the observations of Dr. Bancroft in Australia, and of Dr. Lewis himself (as referred to on pp. 85-89). The fact of the persistence of the envelope of the ovum as a diaphanous sheath, surrounding each of the young embryos found in the blood of man, would seem to the writer strongly to suggest the probability that the embryos in question have been liberated at once into some portion of the vascular system, rather than that they have entered it from without by penetrating its walls. If such a process of struggling through tissues were to take place, their thin diaphanous envelopes would stand a good chance of being torn and left behind.

Nematoid helminths have long been known to occur in the blood of many birds, and Dr. Lewis says: "I have examined a considerable number of the ordinary Indian crow (*Corvus splendens*), and have found that the blood of nearly half of those which have come under my notice have contained embryo hæmatozoa of this character. Sometimes they are in such numbers as to make it a matter of surprise how it is possible that any animal can survive with so many thousands of such active organisms distributed throughout every tissue of its body. The birds did not appear to be affected in the slightest degree by their presence. In their movements they are very similar to the nematoid embryos found in man; they are, however, considerably smaller, and manifest no trace of an enveloping sheath."

Again, observations made many years ago by MM. Gruby and Delafond went to show that 4 to 5 per cent. of the dogs in France harboured microscopic nematodes in their blood; Lewis ascertained in 1874 that more than a third of the pariah dogs of India are similarly affected, whilst Dr. P. Manson has shown that this kind of parasitism affects at least an equal proportion of dogs in China. The embryo nematodes belonging to dogs of these

different countries seem to agree with one another in all their characters. It is important to note that their presence is not associated with the existence of any definite disease. The dogs harbouring such parasites are outwardly indistinguishable from others which have them not. Strange as this may seem, it is also strange that the mode in which the embryo organisms gain access to the blood is still involved in great obscurity. It is true that, by several observers at different times, thread-like mature nematodes (*Filaria immitis*) have been found in more or less abundance in the right chambers of the heart of the dog. These have been found to be extremely common by Dr. Manson in China, and might therefore naturally enough be considered as the source of the multitudes of embryo nematodes found in the blood of these animals. But if true for China, it ought also to hold good for India; yet Dr. Lewis says:—"It seems somewhat strange that, notwithstanding the marked prevalence of embryo hæmatozoa, the *Filaria immitis* has not, so far as I can learn, been recognised in India. I have often searched specially for it but in vain. The only mature parasite which appears to affect the circulatory system of dogs in this country is the *Filaria sanguinolenta*, a description of which, together with an account of the pathological changes which are caused by it during its development in the walls of the aorta and adjacent tissues, was published by me in 1874."[1] But then, the same writer adds:—"Notwithstanding the circumstance that this is the only mature helminth which I have found associated with the embryo hæmatozoa of India, I cannot believe that there is a genetic connection between them, for it frequently happens that the mature worm may be present in abundance unassociated with blood embryos of any kind, and sometimes it is found that the latter exist without any trace of the former."

What has been said above suffices to show the very considerable gaps in our knowledge concerning the life-history of the Nematoid hæmatozoa of man and animals, and also the tendency so frequently met with among some observers to bridge these gaps by unsatisfactory explanations deduced from a too-narrow survey of the facts—a perennial source of error peculiarly common in regard to this class of questions.

Of the protozoa referred to as being found in the blood of the lower animals the newest and perhaps the most interesting are those now first described by the author as existing in that of Rats. Being directed by the Indian Government to make observations on the spirillum occurring in the blood of patients suffering from the Bombay fever, the author says: "Whilst doing this I had occasion to examine the blood of a considerable number of animals, and eventually (July, 1877) detected organisms in the blood of a rat which, at first sight, I took to be of the nature of vibrions or spirilla." The organisms, of which figures and photographs are given, are each of them provided with a long and very distinct flagellum, though otherwise they are not very different in appearance from some bacilli. Subsequent observations showed Dr. Lewis that whilst such organisms do not seem to exist in the blood of mice they are to be found in two species of rats, viz., *Mus decumanus* and *Mus rufescens*. Concerning their prevalence and pathological significance in these animals, he says:—"I have examined the blood of a great number of rats for the purpose of ascertaining what proportion of them contains these organisms in their blood, and find that of those specially examined for this purpose, their existence was demonstrated in 29 per cent. Sometimes, however, the numbers detected were very few, not more than one or two in a slide, but in the greater number of cases they were very numerous, every slide containing several hundreds. . . . . With regard to the health of the rats in which these flagellated organisms were detected, there was nothing to suggest in any way that they were less healthy than others not so affected, and I have repeatedly kept rats for a considerable time for the purpose of observing whether any special symptoms would be manifested. . . . . When it is considered that thousands of active beings of this character can exist in the blood without in any appreciable manner affecting the health of their host; and when it is further considered that these organisms must consume at least as much, if not far more, oxygen than bacteria, bacilli, and spirilla, it becomes difficult to understand how it comes about that, to a like action on the part of the latter is ascribed the asphyxia and the other morbid conditions which characterise death from splenic disease and allied affections." Such a view has been put forward by MM. Pasteur and Joubert, though it is well known, and has been pointed out by Virchow amongst others, that the proportion of bacilli in the blood at autopsies, bears no sort of relation to the severity of the disease previously existing in the persons under examination.

But it is in regard to these vegetal organisms existing in the blood of man and some animals that the larger part of Dr. Lewis's memoir refers. He evidently entertains a clear view of the principal phenomena to be considered in reference to this part of the subject, and exhibits a rare absence of a tendency, which is unfortunately but too common, to slur over fundamental difficulties standing in the way of the acceptance of the "Germ Theory of Disease"—or the "Doctrine of Contagium Vivum" as it is sometimes termed. In addition to acute criticism Dr. Lewis has made known some very significant and important new facts.

After referring to the generally received view that organisms of the bacterium or bacillus type do not exist to any recognisable extent in the blood of healthy animals, and to the experiments made some years ago by Dr. Douglas Cunningham and himself, which showed how quickly, after such organisms had been purposely introduced into the blood of healthy animals, they disappeared therefrom, he says:—"It may be safely affirmed that their presence in appreciable numbers is, judging from experience, incompatible with a state of perfect health." The case in regard to these microphytes is, therefore, different from what has been stated to obtain with the animal organisms before mentioned, which may swarm in the blood of creatures who are in other respects quite healthy.

One or other of such microphytes has been found to be generally present in *charbon* or *splenic fever*, and in *recurrent fever*. M. Pasteur has of late maintained that *septicæmia* is also characterised by the existence of such organisms in the blood during life; and to this list Dr. Klein adds the so-called *typhoid fever* of the pig.

[1] "The Pathological Significance of Nematode Hæmatozoa."

It is impossible to follow the author through his discussion (pp. 11-34) of the leading facts regarding the connection of microphytes with the diseases above mentioned, but we may briefly consider the question of their causal relation to the morbid conditions with which they are severally associated.

If the organisms of this type commonly met with outside the organism are not specifically injurious when introduced into the bodies of higher animals (and this has been abundantly proved and is commonly admitted), then, the notion that those met with in certain diseases are causes thereof, must necessarily be associated with the belief that they are organisms in some way distinct from the common forms. And this is generally the case; as Dr. Lewis says:—"All the advocates of the germ theory, with very few exceptions, maintaining that the particular organism, in the particular disease in which they are specially interested is wholly distinct from all others."

This is a position which is far from having been proved, however, and is by itself an extremely questionable doctrine. There are no real morphological characters separating the bacillus of splenic fever or of "pig typhoid" from the bacillus of hay, of urine, and of multitudes of other organic mixtures. So far as morphological characters are concerned, this is practically admitted; but then it is contended by Cohn and others that difference in "physiological property" may afford sufficient ground for the establishment of specific distinctions, even in the face of morphological similarity. This is a rather hazardous doctrine, and requires to be advanced with the greatest caution. To what extent in the vegetal and in the animal scale is it to hold good; or is it to be a distinctive character confined to the most protean and highly modifiable of all organisms? On the one hand we find such an authority as Prof. Cohn of Breslau supporting the notion; on the other a scarcely less weighty authority, Prof. Nägeli of Munich, declaring that he is unacquainted with any facts really supporting such a view. He says: "I have during the last ten years examined some thousands of different forms of fission-yeast cells,[1] but (excluding *Sarcinæ*) I could not assert that there was any necessity to separate them into even two specific kinds."

Bacilli, born and bred in the midst of the blood and tissues of a diseased animal, might have certain slight molecular differences impressed upon them, by reason of which they may tend during their nutritive life-processes to secrete a poisonous chemical principle—just as the common putrefactive bacteria are known to do—and it may thus happen that the progeny of such organic units born in morbid fluids or tissues, are capable of setting up morbid processes in the animal economy such as do not follow from the addition to it of bacilli nurtured in a bland hay infusion. This is a mere surmise, thrown out as a view which may be found by some to be easier of acceptance provisionally than the notion that, among the most variable of organisms, from a morphological point of view, several "species" present themselves under precisely the same form, and that identity or difference of "species" is to be judged by the mere effects produced by their invisible molecular activities.

Further, it should be borne in mind that the association between the organisms and the diseases in question is not absolutely constant, nor is the severity of the disease in the least proportionate to the abundance of the organisms found in the animals affected. Speaking of recurrent fever Dr. Lewis says:—"Whereas spirilla could generally be detected in cases of fever of this kind, nevertheless cases every now and then occurred in which perfectly competent observers failed to detect them in the blood from first to last, and this too in cases not a whit less severe than those in which the organisms abounded and which were under the care of the same observers during the same period." This was the experience of Dr. Lewis himself.

Again, in regard to the same disease, the assumed cause will not operate when it is placed under the most favourable conditions—conditions in which it is scarcely conceivable that the organisms should fail to operate were they the veritable causes of the disease. Alluding to well-known experiments made by Obermier, the discoverer of the spirilla of recurrent fever, our author says:—"The inoculative experiments which he undertook, consisting of the injection of spirillum-blood of fever patients into the veins of dogs, rabbits, and guinea-pigs proved abortive, nor was there any effect produced by the injection by means of a subcutaneous syringe of small quantities of such blood into the bodies of healthy persons." Others likewise failed to reproduce the disease by similar means, though one observer states that he had been more successful in thus setting up the disease—irrespective, however, as he says, of the presence of spirilla in the blood with which inoculation was made.[1]

What manner of cause then is this, whose effects take place in its absence, in no corresponding ratio when present, or whose presence is followed by no effect at all? One of a strange order, truly!

But now we come to a great difficulty, an all-important matter, which in its turn has to be explained by those who cannot accept the notion that the microphytes to which we have been referring are causes of the diseases in question. Those who hold the opposite notion will naturally say to the opponents of the germ theory—But, if these organisms are not to be regarded as causes of the disease how do you account for their very frequent presence in association therewith?

Communicable or contagious diseases constitute a large class, and those in association with which microphytes have been found form only a small minority. Seeing the multitudes of observers who have been searching for them for years past in the blood of persons suffering from such affections as scarlet fever, small-pox, measles, and others, the chances that any such organisms will be found in association with these diseases may be said to be diminished to a minimum. Therefore, in so far as concerns the very frequent occurrence of organisms in the blood of persons suffering from recurrent fever, splenic fever, and some other maladies, it would be perfectly consistent (if conformable with other evidence) to regard such organisms as quasi-accidental products or epi-phenomena of the diseases in question.

If we accept the doctrine of Pasteur, Lister, and others to the effect that the blood of all healthy animals is invariably free from such microphytes, the appearance of

[1] That is, the *Schizomycetes*, in contradistinction to the true yeast-cells.

[1] The relations of this spirillum to other known spirilla is discussed at pp. 46-48.

organisms in the blood as epi-phenomena in the course of certain diseases can scarcely be explained except by the supposition that archebiosis or heterogenesis (one or both) have taken place in their altered blood, or in blood and tissues simultaneously.

This the present writer long ago pointed out, and he strongly insisted upon it in a paper published about eighteen months ago,[1] but which does not seem to have reached Dr. Lewis before the printing of his present work. Attention was there specially called to the fact that organisms speedily appeared in the blood of previously healthy animals or of human beings suddenly killed, in such situations and under such conditions as to make it almost impossible to account for their presence except by the occurrence of one or other of the processes above mentioned, giving rise *in situ* to a new birth of such microphytes. Organisms can, in fact, be made to appear at will (as Lewis and Cunningham, as well as Sanderson, had shown) in localised parts of previously healthy organisms by lowering the nutrition in certain ways of such parts of the body, *i.e.*, by either tying the artery supplying the part with nutrient fluid, or by subjecting the part to the influence of some germless chemical irritant. On the other hand, when the nutrient processes throughout the body are checked by the death of the animal, the production of microphytes, which was before local, now, as the writer has several times pointed out, becomes general.

Let the germ-theorists look to these facts and give us a better explanation if they can; because in the cases above referred to, organisms appear in tissues which they themselve have proclaimed to be germless, and in blood which they have declared to be free from all antecedent signs of microphytes.

The facts of the latter order have been distinctly confirmed by Dr. Lewis. He says: "Rats were obtained, killed by means of chloroform, and set aside from three to twenty-four hours or longer, according as the temperature of the atmosphere was high or low. The result proved that almost invariably bacilli were to be found in the blood, in the spleen, and in other organs."

It appears, however, and the fact is one of considerable significance, that when death takes place in certain modes (as by poisoning with carbonic acid or carbonic oxide), organisms have a still greater tendency to appear in the blood and that they manifest themselves with surprising rapidity.

A man who was sent to seek for rats, having found, "That he could procure more than could be accommodated in the cage which he had brought with him, he obtained a large earthen vessel, transferred twenty-seven rats into it, and tied a piece of cloth over the mouth of the vessel. As may be supposed, the rats had perished before he got home—all except one. . . . I examined the blood and the spleen of twenty of these rats within about six to eight hours of their having been caught, and found in each case that there were innumerable bacilli present, in every way morphologically identical with *Bacillus anthracis*.[2] In some of the cases the number was astonishing. They were present chiefly in the form of rods, but here and there some were seen to have grown to such a length as to cover two fields of the microscope. . . This experience tends to give support to the statement made by M. Signol before the French Academy, to the effect that motionless bacilli identical with those found in charbon, will be found in sixteen hours, or less, after death, in the blood of animals which have been asphyxiated by means of a charcoal fire."

Dr. Lewis shows that these organisms which make their appearance within the bodies of animals so soon after death are not only morphologically indistinguishable from *Bacillus anthracis*, but that they go on, under suitable conditions, to the so-called "spore" formation in precisely the same manner. The characters of these organisms under different conditions are well shown in Pl. I.

But if mere modes of dying influence the quickness with which such organisms appear in the body after death, it is not inconsistent to suppose that they may in certain cases—that is, in association with certain morbid processes—be much more prone than in others to show themselves as epi-phenomena. And this seems to correspond with what actually occurs; in many contagious diseases, as above stated, such organisms seem to be absent, in a few they show themselves, and that by far the most frequently in cases where death is already pretty closely at hand.

Referring to the bacilli met with in malignant pustule (charbon), septicæmia, and the so-called "typhoid fever," in the pig, horse, and other animals, Dr. Lewis says: "It may be confidently stated that they are never to be detected in the earlier stages of the disease, but only at a brief period before and after a fatal termination. To my knowledge they have never been found in the blood of animals which have subsequently recovered; they have always been recognised only as one of the concomitants of impending dissolution. This is undoubtedly the case so far as the two diseases first cited are concerned."

Those who are the warmest advocates of the germ-theory of disease—a doctrine resting on sufficiently unstable foundations—are not always cautious or discreet in the way they speak of others who lean to a belief that the organisms met with in association with disease are mere epi-phenomena, often produced within the body by a process of heterogenesis. Yet the latter interpretation, so far as present knowledge goes, seems to the writer essential for the explanation of our power to determine, at will, the presence of microphytes in the germless tissues or germless blood of previously healthy animals.

H. CHARLTON BASTIAN

[1] "On the Conditions Favouring Fermentation, &c.," *Journal* of Linnean Soc. (Zool.), vol. xiv. pp. 89-93.

[2] That is, the bacillus met with in association with charbon or splenic fever.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

Antiquity of Orchids

I HAVE been struck by a most cogent remark of Mr. Wallace's in his review of Mr. Allen's "The Colour Sense" (NATURE, vol. xix. p. 501), viz., "But surely in orchids the perianth

more highly specialised than in any existing flowers whatever; and if we take into account the world-wide distribution of these plants, their intense richness in genera and species, and their wonderful complexity of structure, we must consider them as among the most ancient instead of the most recent of flowers."

Without venturing any opinion as to the geological age to which the development of this wonderful order of plants must be traced back, it seems to me that there are some classes of facts concerning our native European species which support the conclusion that their existence in their present specific characters must date from a very remote time.

1. It is an important fact that out of fifty species of orchids enumerated in Garcke's "Flora des deutschen Reiches" (exclusive of the Bavarian Alps, which possess two or three more species), not less than forty-one occur in the British Isles (besides *Neotinea intacta* and *Spiranthes romanzoviana*, not found in Germany), a proportion considerably exceeding that of phanerogams generally. Now, as it seems scarcely credible that orchids should possess means of transportation across the sea in preference to other plants, we must conclude that they inhabited the British Isles before their separation from the Continent, which involves that they occupied stations near the present coasts of Germany or France previous to a great deal of plants that reached these coasts only subsequently to the formation of the Channel. These conclusions are rather strengthened by the fact that several orchids are by no means frequent in Germany, and very rare and local in Britain, which proves that their occurrence is not to be accounted for by favourable present conditions, and even renders it probable enough that some of the species found in Germany, but not in Britain, may in the latter country have become extinct in times not very long ago.

2. Notwithstanding the light so plentifully thrown on the significance of the floral peculiarities of our orchids by Mr. Darwin's admirable investigations, there remain some species whose relations to insects, although evidently of a most specialised nature, are yet very little understood. Such seems to be the case with Himantoglossum and with Ophrys. It is therefore to be suspected that the adaptations of these species may point to insects no longer existing in our countries. However, I should not insist on this point were it not somewhat connected with the following:—

3. It has been observed by Mr. Darwin that "the frequency with which throughout the world members of various orchideaceous tribes fail to have their flowers fertilised, though they are excellently constructed for cross-fertilisation, is a remarkable fact." And further on Mr. Darwin alludes to the unknown causes which lead to the destruction of seeds or seedlings, forming a check to the multiplication of orchids. Indeed, with many of our native species, though abundantly fertilised, multiplication by seeds is evidently but a rare exception to the general rule of propagation by side-bulbs, *i.e.*, mere individual persistence. Thus the wonderful contrivances for cross-fertilisation point back to different conditions of life in the past, under which their function must have been much more active and important than it is now.

There may, I think, be found analogous cases in very different quarters of the vegetable kingdom; for instance, the frequent reduction of the peristome of mosses to mere rudiments is probably connected with actual preponderance of vegetative propagation over propagation by spores. In the orchids, too, there are already perceptible some traces of a regressive change of the apparatus for cross-fertilisation (for instance, in *Ophrys apifera*), as will be inevitable in the course of ages, whenever specialised structures are no longer sustained by active function, leading to their reproduction under the agency of natural selection. Perhaps such regressive change goes on more slowly in cases of merely vegetative propagation.

Finally, I may allude to the fact of our native orchids belonging to very different groups of the order, and this enhances the argument for antiquity, based on their geographical distribution. D. WETTERHAN

Freiburg im Breisgau, May 10

Barometric Pressure and Temperature in India

IN order to satisfy myself as to whether some of Mr. Broun's conclusions (NATURE, vol. xix. p. 6) held good when inland stations were included in the comparison, I recently examined in detail the pressure and temperature oscillations at fifty-one stations in the Indian peninsula, computed from the means given in Mr. Blanford's "Indian Meteorologist's *Vade Mecum*." As these stations represent every part of the country, the results afford a basis for deduction of sufficient extent to be reliable.

An inspection of these shows (1) that the range of pressure-oscillation corresponding to 1° F. *varies* very much at different places, its extreme limits being 0·002 in. at Leh, and 0·032 at Vizagapatam, and its mean value for all the stations 0·017 in.

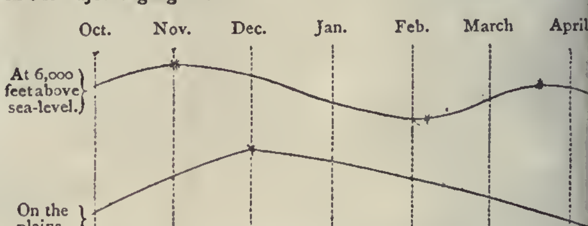
2. That on arranging the stations in order of elevation, it is plain that this variation is partly related to the height above sea-level, being least at Leh (11·538 feet), the most elevated station, and increasing from thence downwards at the mean rate of about 0·002 in. for every thousand feet of descent. The numerous deviations from this rule, however, especially at the lower elevations, make it evident that other factors operate besides height, such as distance from the coast and latitude. Though no rigorous comparison with these has as yet been made, a mere inspection of the results is enough to show that proximity to the sea, and, therefore, *ceteris paribus*, greater humidity is associated with a greater barometric oscillation corresponding to 1° F.[1]

3. That when the element of horizontal space alone is considered, the pressure oscillation increases with the temperature oscillation, but not very regularly, and that while this relation holds pretty generally in the plains, it disappears altogether at the more elevated stations, or, when the element of vertical space is introduced.

Now while the pressure ranges generally decrease pretty regularly as we ascend, the temperature-range remains about the same at different heights. The decrease, therefore, in the pressure-oscillation for 1° F., noticed in the case of elevated stations, must plainly be solely due to the contraction which takes place in the pressure-range.

The diminished mass of atmosphere above the more lofty stations, doubtless in a great measure accounts for this diminished amplitude of the oscillation. Another important factor, however, in this result, must not be overlooked, viz., the *double* annual oscillation of monthly mean pressure which takes place at stations of 6,000 feet and upwards in height, apparently throughout India, the effect of which is sensibly to diminish the absolute annual range of pressure-oscillation at these heights.

In fact, the curves representing the mean monthly barometric pressure in the winter at the hills, and on the plains respectively, may be taken to approximate more or less in character to those in the adjoining figure.



Pressure Curve (the critical points are marked with asterisks).

Now as the pressure on the plains is made up of the pressure at a height of 6,000 feet + the weight of the stratum of air between, it is evident that the latter must reach its maximum somewhat later than December. Moreover, as the winter depression at the highest stations is considered to be caused by the inrush at their level of the saturated anti-monsoon at this season,[2] the direct effect of the cold of this season in increasing the density, and hence the pressure of the atmosphere, will only be felt in the stratum of air between them and the plains. It is im-

[1] This relation appears to be independent of that due to elevation, with which it might be thought identical, owing to the general decrease in the heights as we travel seawards. The following stations which have nearly the same elevation, but are at widely different distances from the sea, will show this very clearly:—

	Height above sea in feet.	Bar oscillation for 1° F.
Lucknow	369	0·017
Sibsagar	332	0·028
Difference ...	37	0·011

Now if the approximate rule for difference of elevation already mentioned, viz., a decrease of 0·002 inch in the bar-oscillation for 1° F. for every 1,000 feet of ascent be applied in this case, the decrease at Lucknow should evidently be inappreciable. As it is, however, it is of very considerable magnitude.

[2] *Vide* "Indian Meteorologist's *Vade Mecum*," by H. F. Blanford, p. 75.

portant, therefore, to find out when the maximum average density, or what is practically the same thing, the maximum barometric weight of this stratum, occurs, and more especially to see whether it coincides with the epoch of minimum temperature, which, as a rule, occurs in January throughout India.

The following table, in which I have calculated the mean monthly barometric weight of such a stratum in different part of the country, will show that the maximum invariably occurs in January, that is to say, it *coincides* with the epoch of minimum temperature. Two bars placed underneath a figure indicate the maximum pressure or weight of the year; one bar, the secondary maximum at the hill-stations in the spring.[1]

Stations.	Elevation above sea-level in feet.		Mean monthly barometric pressure in inches. October.	November.	December.	January.	February.	March.	April.
Leh	11,538		19·714	·707 *	·728	·553	·571	·656	·630
Lahore	732		29·144	·262	·332	·243	·237	·107	28·962
Stratum between—thickness	10,806	weight	9·430	·555	·604	·690	·666	·451	·332
Chakrata	7,052		23·332	·356	·352	·304	·313	·325	·309
Roorkee	887		28·965	29·102	·150	·108	·050	28·965	·853
Stratum between—thickness	6,165	weight	5·633	·746	·798	·804	·737	·640	·544
Darjeeling	6,912		23·436	·472	·449	·382	·368	·364	·363
Goalpara	386		29·461	·593	·641	·610	·544	·459	·383
Stratum between—thickness	6,526	weight	6·025	·121	·192	·228	·176	·095	·020
Ranikhet	6,069		24·108	·180	·158	·079	·070	·055	·070
Lucknow	369		29·503	·651	·696	·641	·596	·481	·348
Stratum between—thickness	5,700	weight	5·395	·471	·538	·562	·526	·426	·278
Wellington	6,200		24·217	·245	·256	·208	·226	·246	·247
Madras	22		29·847	·922	·965	·944	·921	·895	·843
Stratum between—thickness	6,178	weight	5·630	·677	·709	·736	·695	·649	·596

* To avoid repetition, I have merely given the decimals after the first column. In every instance of omission the last prefixed integer is to be supplied.

Without going any deeper into the matter, it must, I think, be generally admitted that the preceding facts not only dispose of Mr. Broun's objection to the idea that pressure and temperature are related, because the epoch of maximum atmospheric pressure on the plains of India generally *precedes* that of minimum temperature, but also show how abortive any attempt to base inductions regarding a secular variation in solar heat, upon the results of comparing the annual range of monthly mean pressure, or even the mean annual pressure, for a number of years in succession in different parts of India, must necessarily prove, unless they be duly taken into consideration.

With reference to Mr. Broun's conclusions alone, the following modifications should be attached, according to the results of my investigation.

1. The annual oscillations of monthly mean pressure and monthly mean temperature bear an exceedingly *variable* ratio to one another in India, such variation being a function partly of the altitude, and partly of the distance from the coast.

2. Non-coincidence of the critical epochs of monthly mean pressure and temperature, cannot be rigorously employed as an argument against the hypothesis, hitherto generally accepted, of a causal connection between them.

E. DOUGLAS ARCHIBALD

Insect Galls Buds

INSECT galls are held to be "excrescences"; a "diseased condition of vegetable tissue"; and they are supposed to result from the "injection of a fluid," or from some "secretion." The student may most easily begin an investigation of galls with the dissection of those produced by the turnip weevil (*Curculio pleurostigma*) on the bulb of the Swede. The roots of Swedish turnips are frequently covered with hundreds of irregular spherical warts, from ·03 to ·75 of an inch in diameter, growing either singly or crowded together in clusters. These warts are regarded by M. Woronin (*Plasmodiophora brassicæ*, Pringsheim's *Jahrb.* xi. B. p. 548) as resulting from the fungus which he has discovered to be the cause of club-rooting in cruciferous plants. I believe that on this point M. Woronin has been misled. The true clubs produced by his fungus are entirely distinct from these root-nodes. Under favourable conditions the root-nodes have been found to give rise to tufts of leaves; a fact which I can confirm by many examples presently growing in my possession. Dissection of these nodes, on Swedes, shows that they contain none of the plasma and spores which constitute the bulk of the true clubs. They are, in fact, tuberculated buds arising directly from medullary rays in the root to which they are attached. These can be traced through the enveloping parenchyma into the nodes, where they are seen to give rise to masses of contorted and branching leaves. The nodules within the bark of the beech, hazel, and other trees, are of the same character as those on the turnip. The medullary nexus of these nodules sometimes comes straight from the centre of the tree into the node, and sometimes runs along like a cord under the outer layers of the bark, entering the node by the end.

Let a dissection now be made of one of the weevil galls on the bulb of the turnip. The second or third slice will show the outer foliations, exactly similar to those of the root buds. When the centre has been reached, where the maggot will be found, there will also be found a vascular pencil running up from a medullary ray in the bulb, and bearing on its top a bud of the same description as that produced by a ray running out from a root. The insertion of the ovipositor brings a medullary ray into action, producing a tuberculated bud, and it is only the bud which the larva feeds upon. The growth of a bud is an intelligible cause of the growth of a gall, but we can infer nothing from the injection of a fluid.

All insect galls are in reality leaf-buds, or fruit-buds. They are not mere amorphous excrescences. The vascular lines which would form leaves can easily be followed up the structure of the oak-leaf galls. And in cases where the egg has been deposited in the tissue of a young branch the cap of the gall is sometimes surmounted by a leaf two or three inches long. But in the large blue Turkish galls many lacunæ occur where the fleshified leaves have not filled up the spaces between them. The morphology of the hollow woody shell, and its inclosures of starch, &c., found in the interior of these galls I hope to work out by and by. It is a curious fact that various microscopic fungi are matured in the interior of imperforate galls.

A. STEPHEN WILSON

North Kinmundy, Aberdeen

[1] In selecting the particular station on the plains to be used in each case, I have endeavoured as far as possible to fulfil two requisites: (1) proximity to the hill-station, (2) low elevation above sea-level.

Cyclones

Mr. Barham, in Nature (vol. xviii. p. 249), concludes that "a cyclone is occasioned by the meeting and passing each other of a northerly and a southerly current, so that they pass each other on the left hand respectively." Supposing this to be true for the northern hemisphere, we must for the southern hemisphere substitute *right* hand for *left*.

There is nothing in this contrary to dynamical principles, but the facts of the geographical distribution of cyclones appear to show that the eddies or swirls in which they originate are formed, not by north and south currents *passing* each other, but by the same *meeting* each other, that is to say, in the zone where the north and south trade-winds meet, when this zone is at some distance from the equator. Cyclones are not formed on or near the equator, because there the earth has no rotation relatively to an axis drawn vertically to its surface.

Mr. Blanford has written in Nature (vol. xviii. p. 328), showing that Mr. Barham has not accounted for the motive power of the cyclone, and explaining it by the liberation of latent heat from the condensation of vapour in an ascending current at the centre of the cyclone. This explanation was first given by Espy in his "Philosophy of Storms," and is certainly true. But the two questions are quite distinct, viz., what sets the cyclone going? and, how is it supplied with motive power?

Three conditions are needful for the formation of a cyclone—first, an eddy produced where currents of air meet; second, sufficient "steam power of the atmosphere," as Espy calls it, to produce a strong in-draft to the centre of the eddy; third, a position sufficiently far from the equator for the currents of air towards the centre to be sensibly deflected by the earth's rotation.

But how is the in-draft first set up? I reply, by the centrifugal force of the eddy causing a barometric depression at its centre, whence follow cold, the condensation of vapour, and the liberation of heat which had been latent. The liberated heat expands the air in the upper strata, thus supplying the motive power of the cyclone.

Joseph John Murphy

Old Forge, Dunmurry, Co. Antrim, April 20

Showers of Rain and Gusts of Wind

It is a matter of common observation that showers of rain are usually accompanied by more or less violent gusts of wind, but as far as I know no explanation of the fact has yet been offered.

The cause I am about to suggest must be productive of some result, but whether it is sufficient to account for the whole phenomenon I cannot say without quantitative observations, though I guess it is.

It is quite certain that the actual velocity of even large drops of rain is very small compared with that which they would acquire by falling through the same height *in vacuo*, and, practically, a drop may be considered to fall with uniform velocity during the whole time of its descent.

Now, after a drop has ceased to accelerate, it leaves an amount of water in air equal to the weight of the drop multiplied by the distance through which it falls, and most of this will appear as a current of air accompanying and following the drop.

In fact, when the drops which compose a shower are falling without accelerating, the air through which the shower falls is acted on by a downward force equal to the weight of the shower, and the downward current of air thus caused must spread laterally as it approaches the ground.

Thus, if a shower were to fall on a calm day, there ought to be a wind on the ground blowing in all directions from the shower as a centre. The rough experiment of throwing a shovelful of sand into the air and watching the dust as it reaches the ground serves very well to show the kind of thing which must happen. But when there is a wind blowing at the time the shower falls, which is generally the case, another, and perhaps more potent, cause than the mere lateral spreading of the downward current comes into operation.

The wind at the surface of the ground is moving more slowly than that at a higher level, because of the retarding effect of friction, and the effect of the shower will be to import air with a high lateral velocity from the upper regions to the lower, where the velocity is small.

With regard to the magnitude of the force which the shower exerts on the air, if we take the rainfall as 2 centimetres per hour, the velocity of the falling drops as 7 metres per second, and the height of the cloud as 700 metres, not improbable numbers for a thunder-shower, the pressure per square metre of shower is 560 grammes; but the downward velocity which this force would generate in the air would depend on the total area of the shower, and would vary from place to place in the shower itself.

A. Mallock

May 8

Phosphorescence

The study of phosphorescence has lately received a considerable impetus, mainly from its having been made use of in a commercial form for clock faces, door plates, &c., but as Prof. Morton lately remarked, the present producers must have discovered some method of greatly increasing the luminosity of the sulphide used. After great difficulty I succeeded in getting a small quantity from the French makers, the same that I know Mr. Crookes had in obtaining it from the same source. Its luminosity is undoubtedly infinitely superior to that of any of the old methods of production, and gives hopes that further advances may be made. My reason for troubling you with this letter is to put on record a curious fact that has come under my notice in making some experiments detailed in the *Photo News* for May 2, with a view to making luminous photographic images in various ways—that is, that not only light, but heat produces the phosphorescent light. If we take a sheet of card and dust it over with the powder, after coating it with a sticky varnish and allowing to dry, we have a surface that when exposed to daylight for a few seconds will remain luminous for a certain time afterwards. If we place a transparent positive in front we have an evanescent photographic image presented to us on removing to a dark room, but if after simply exposing the sheet to daylight we place the tips of the fingers against the back of the card, spots of two or three times the luminosity will appear at these places showing that the heat from the hand has a great increasing action. The same occurs if the paper has not been exposed to light, the mere warmth of the hand being sufficient to render the sulphide luminous. Here we have light produced by warmth on a small scale. That phosphorescence is yet in its infancy I am convinced, and also that it will yet have a greatly extended future.

Walter B. Woodbury

Manor House, South Norwood, S.E.

A Large Egg

One of my Houdan fowls has laid an egg weighing 7 oz.; her ordinary eggs weigh 2½ oz. I ordered my man to blow the egg in order to preserve the shell, when I was surprised to find that, besides a small yolk and much white of egg, it also contained a *perfect ordinary-sized egg*. This is now lying loose within the large shell, which latter measures 8¼ inches and 9¼ inches in its two principal circumferences.

E. L.

Barham, Ipswich, May 6

THE IRON AND STEEL INSTITUTE

The annual spring muster of this young and vigorous society, now in the tenth year of its age, and numbering close upon a thousand members, was held, according to custom, in the house of the Institution of Civil Engineers in Great George Street, last week. This gathering has been awaited with considerable interest for some time past, as communications of more than usual importance were expected upon the problem of dephosphorising ordinary brands of cast iron, such as are smelted from the stratified ores of Cleveland, Lincolnshire, and Northamptonshire, sufficiently to be able to produce from them steel of fair merchantable quality; and the attendance fully justified the expectations, the large meeting room being, as a rule, filled to overflowing each day within a very few minutes after the opening of the proceedings. With the exception of a morning devoted to complimentary and formal business, including the address of the new president, Mr. Edward Williams, who succeeds Dr. Siemens, and, in a few pages, presented a bold and rapid sketch of the progress of the malleable iron and steel industries since 1855, the year of Bessemer's great invention, and the presentation of the medal to Mr. Peter

Cooper, of New York, the father of the American iron trade, and the founder of the Cooper Institute, probably the largest free technical school in the world, the three days of the meeting were given up to the reading and discussion of papers in the thorough and workmanlike manner that has distinguished the Institute from its earliest meeting to the present time. Of prominent interest among these communications was undoubtedly that by Messrs. Thomas and Gilchrist on the Elimination of Phosphorus in the Bessemer converter, describing a series of experiments in continuation of others previously brought before the Institute, made at Blaeravon and Dowlais in South Wales and at Messrs. Bolckow and Vaughan's steel-works in Cleveland. The essential novelty in these experiments is the use of lime and oxide of iron as a flux in the Bessemer converter, lime being also used as a refracting lining in place of the ordinary siliceous sand or ganister. By this comparatively simple change it is found that the highly phosphuretted iron of Cleveland, containing 1 per cent. and upwards of phosphorus, may be so completely purged from that objectionable metalloid as to yield a steel, or rather, to use the proposed international nomenclature, an "ingot metal," which in this particular compares favourably with that blown from hematite pig-iron, the amount of phosphorus ranging from ·03 to 0·15 per cent. in various samples.

The presence of a large excess of earthy base, *i.e.*, lime, in the slags, appears to be the essential condition of success, and the formation of such a fluid basic slag at an early stage of the operation is of equal importance, as it enables the oxidation of both carbon and phosphorus to go on simultaneously. The composition of these slags is utterly unlike those obtained in the Bessemer process, as ordinarily worked, which are essentially similar to manganese augite; while those of the new process contain from 33 to 37 per cent. of lime, and about as much silica; though not exactly representing any natural mineral, are nearer in constitution to the olivine group of silicates. That the phosphorus is removed as phosphate of calcium, probably diffused through a mass of smolten silicates of calcium iron and manganese, there can be but little doubt, but the point, apart from its practical bearing, is of considerable scientific interest, and it seems not unlikely that microscopic investigation might throw some light upon it, unless, indeed, the slags should prove so opaque as to resist this particular method of inquiry. At any rate, one cannot but be struck with the analogous occurrence of apatite in basalts and other igneous rocks containing a low proportion of silica.

As regards the practical value of the process it would be premature to speak; many of the points raised in the discussion by way of objection, such as the increased volume of slag produced, a serious nuisance in the comparatively confined space of a Bessemer casting pit, the possibly small duration of the converter linings, &c., being obviously only matters of detail. That a very considerable success has been achieved in these experiments there can be no doubt, and that the iron smelters of Cleveland as well as those of Luxemburg and Lorraine will be fully alive to the advantages which the new process promises them is equally certain. At the same time the hematite iron trade, though not so completely master of the field as formerly, will no doubt be fully able to hold its own, and there will probably be found to be ample room for both east and west coast as steel producers. Some among us may hope as a consequence to hear less o the so-called phosphorus steels produced by dosing phos phorised iron with manganese, now that the more rational method of taking the phosphorus out of the iron may be used, in preference to disguising it.

The paper by Mr. Snelus covers nearly the same ground as that of Messrs. Thomas and Gilchrist, as it describes a number of experiments made in Bessemer converters with a lime lining first at Dowlais and subsequently Workington in Cumberland some years since with substantially the same results. That these experiments were not further carried out is sufficiently explained by the fact of the author being at the head of an establishment producing one of the purest qualities of cast-iron in the country, and therefore his interests were not in the direction of making lower class metal available; and any one who knows how the West Cumberland Works have progressed under Mr. Snelus' management will find sufficient excuse for his name not being more prominently identified with the new process. The fact of a West Coast man having been the first to demonstrate the feasibility of steel-making from Cleveland iron is a source of gratification to the local papers, and to those who have neither Cumberland nor Cleveland proclivities, it will be gratifying to know that two of the three authors of the paper in question, namely, Messrs. Gilchrist and Snelus, are graduates of the Royal School of Mines. As a contribution to the working out of the practical details of the process, Mr. Riley's paper deserves notice, although no very considerable principle is involved. The use of lime as a lining for Bessemer and other steel-melting furnaces is attended with some difficulty, as the consolidation of dry quicklime by ramming and subsequent heating is in many ways an unsatisfactory method, and its conversion to a plastic mass by means of water is not possible, owing to the chemical changes set up by hydration. These inconveniences Mr. Riley proposes to remedy by making the lime plastic with petroleum or other hydrocarbon oils, giving a mass which can be moulded by pressure and consolidated by burning in the same way as ordinary fire-bricks, the small quantity of oil being driven off at the temperature of firing. The material used is the magnesium limestone of Yorkshire, which gives bricks sufficiently hard to resist carriage and a certain amount of hard usage. Of the other papers read, that by Mr. Pattinson, of Newcastle-on-Tyne, describing a new method of determining manganese in iron and iron ores, is of considerable value as giving an exact method of indirect analysis which can be carried out in a short time as an alternative to the rather tedious direct methods of determination at present in use.

The remaining communications, more particularly those on the various uses of steel, as for example, in ship building by Mr. Barnaby, in bridge building by Mr. Maynard, and in general engineering work by Mr. Adamson, though of interest, are more so from the discussions produced than from any positive information contained. The close of the meeting was marked by the announcement of Dr. Siemens' munificent offer of 10,000*l.* towards the building fund of a new house for the Institute and the other societies representing applied science, to be erected in Westminster, a project which has been spoken of for some time, but which will no doubt with such a favourable beginning soon become a reality. It is to be hoped that in erecting a new scientific palace, whether on the Thames Embankment or elsewhere, the example of Burlington House will not be followed, where a large and costly pile of buildings has been erected without a single good-sized meeting-room in any one of the houses.

THE METEOROLOGICAL CONGRESS AT ROME

THE second International Congress of Meteorologists has just been held at Rome, on the invitation of the Italian Government. At the time of the first Congress at Vienna in 1873, it had been wished that a second should take place in three years' time, but for various reasons the meeting was postponed until Easter, 1879. Delegates were present from all the countries of Europe except Turkey, and Gen. Myer of the United States crossed the Atlantic, but, unfortunately, to arrive too late. The actual foreign delegates present were:—(Aus-

tria) Dr. Hann, Dr. Lorenz, Dr. Paugger, Dr. Müller, and Lieut. Weyprecht; (Hungary) Dr. Schenzl; (Bavaria) Dr. v. Bezold; (Belgium) Prof. Houzeau; (Denmark) Capt. Hoffmeyer; (England) Prof. Smith and Mr. Scott; (France) M. Hervé Mangon, Prof. Mascart, Lieut. Brault; (Germany) Dr. Neumayer, Dr. Bruhns, Dr. Auwers; (Greece) Prof. Kokides; (Holland) Dr. Snellen; (Norway) Prof. Mohn; (Portugal) Capt. de Brito Capello; (Russia) Prof. Wild; (Spain) M. Aguilar, Capt. Pujazon; (Sweden) Prof. Rubenson; (Switzerland) Prof. Plantamour; Italy sent Prof. Blaserna, Prof. Palmieri, Padre Denza, Prof. Tacchini, M. Salvatori, Prof. Pittei, and Prof. Cantoni. Of foreign guests there were present Dr. Hellmann, Prof. Mendeleef, Prof. Weihrauch, and Prof. Zenger.

Prof. Buys Ballot, the president of the Committee which had made the preparations for the Congress, was unavoidably absent, owing to domestic affliction, and his place was taken by Prof. Cantoni, who was elected president of the Congress. MM. Plantamour[1] and Wild were elected vice-presidents, with Capt. Hoffmeyer and Mr. Scott as secretaries.

The proceedings were opened on April 14 by M. Depretis, the Premier, in the absence of the Minister of Agriculture and Commerce, M. Majorana Calatabiano. A reply to his speech had been prepared by Prof. Buys Ballot, and was read by M. Mascart. Mr. Scott then read the Report of the Permanent Committee of the Vienna Congress, containing a list of the special treatises prepared for submission to the Congress at Rome. The existence of these treatises, several of which are of considerable value, forms the most important feature of the proceedings of the meeting of 1879.

For the consideration of the several questions of the programme, five committees were appointed: 1. Organisation; 2. Publications; 3. Instruments and Observations; 4. Telegraphy, Maritime Meteorology and Agricultural Meteorology; 5. Distant Stations and Mountain Observations. The Committees met frequently, and the Congress held five general meetings, concluding its business in eight days of very hard work.

The following will give a general idea of the resolutions adopted:—

The idea of an international institute met with very little favour, but instead thereof, an international meteorological committee consisting of nine members was elected. This body possesses no executive powers, but is charged with the duty of endeavouring to forward the prosecution of definite inquiries into various meteorological problems by friendly co-operation between the several institutes and individuals who may be disposed to undertake such inquiries, as, *e.g.*, the construction of isobaric charts for the globe. The committee has also to see to the carrying out of the resolutions of the Congress, and to report on the degree to which those of the Vienna congress have been carried out. The members of the committee are chosen from different countries, and their names are as follows:—

Buys-Ballot (Holland), Cantoni (Italy), Capello (Portugal), Hann (Austria), Mascart (France), Mohn (Norway), Neumayer (Germany), Scott (England), Secretary, Wild (Russia), President. All communications are to be addressed to Mr. Scott. As regards the form of publications, the schedules proposed in 1874 by the permanent committee of the Vienna congress were adopted, and, ir fact, are already very generally in use. The Congress took no measures to enforce uniformity of hours of observation, the problem presenting too many difficulties. Each country was invited to prepare for its own principal stations corrections for diurnal range for the more important elements. The preparation of a catalogue of existing meteorological literature, including papers in periodicals, was recommended, such catalogues having already appeared at Brussels and in London (for the library of the Meteorological Society).

With reference to the subjects embraced under "instruments and observations," the most important resolutions were the following:—

The different institutes were recommended to effect a comparison of their respective standard instruments; the method of determining the fixed points of thermometers proposed by M. Pernet in his report on the subject was provisionally approved; the Congress did not venture to prescribe a single mode of exposure for thermometers suitable to all climates; the subject of earth-temperature was strongly recommended for study. The Congress received a communication from a M. de Rossi, on what he calls "endogenous meteorology," *i.e.*, the influence of atmospherical changes on earthquakes, and recommended him to prosecute his studies further.

The regulation of the Vienna congress in favour of very large rain gauges was rescinded, as well as that prescribing a height of 4½ feet above the ground for the instrument.

The international telegraphic code proposed in 1874 was recommended for general adoption. It was not found practicable to introduce into it a notice of "cirrus" cloud observations, but this latter subject was strongly recommended for study.

The subject of ocean meteorology was left to the special offices which are occupied therewith. With reference to the simultaneous observations made for the U.S. Signal Office, the Congress hoped they will be continued. As to the construction of daily synoptic weather charts for the Atlantic and Europe, a joint proposal by Dr. Neumayer and Capt. Hoffmeyer to continue and enlarge the scope of the charts published by the latter gentleman was approved. In regard of agricultural meteorology, it was decided to recommend that a private conference of persons interested in and possessing special knowledge of the subject should be held in the course of the next twelve months.

With reference to the establishment of stations in distant islands, as, *e.g.*, in the Pacific Ocean, it was decided that none such could be organised by international co-operation, but that individual governments should be requested to found stations in such localities, and that all maritime nations should be requested to instruct the officers of any exploring expeditions they may respectively send out to visit any such outlying stations as occasion may offer.

As regards Continental stations in low latitudes, the Congress resolved to request the Brazilian Government to establish meteorological stations, and to request the Royal Society of London to endeavour to secure the continuation of the publication of Mr. J. Allan Broun's work at Trevandrum. Several resolutions were passed relating to the importance of observations taken in balloons and on mountain tops. The subject of the changes in the size of glaciers, as indicating changes of climate, was recommended to the notice of the Alpine Clubs.

The final resolution of the Congress had reference to the proposal of Count Wilczek and Lieut. Weyprecht to maintain for a year a series of observing stations round the North Pole. It was resolved that, if possible, an official conference of representatives from governments disposed to co-operate in the undertaking should be held at Hamburg in October next; M. Weyprecht explaining that he could not accept a later date for the conference, as his own departure for Nova Zembla, his chosen post, would take place before next spring, and as the funds for his expedition were already contributed. The meetings terminated on April 22.

The Congress was entertained with the most splendid hospitality. His Majesty the King received the delegates at a banquet on April 21, on which occasion they were

[1] M. Plantamour's name was inadvertently omitted from our note of NATURE, vol. xix. p. 590.

personally presented to the King and Queen, who conversed most graciously with each of them. On the 22nd the Minister of Agriculture entertained the Congress at a State dinner. On the 20th the Syndic of Rome had given a reception in the Capitoline Museum, which was illuminated for the occasion. For their own part the foreign delegates invited their Italian hosts to a dinner at the Hotel de Russie on the 19th.

The proceedings were closed by a very graceful and munificent act of hospitality. The entire Congress, with the ladies who had accompanied some of the members, received free tickets for Naples and became the guests of the Italian Government for two days and a half. An expedition to Vesuvius, which was arranged for them, proved a complete success. The courtesy and forethought of the Italian officials extended to every detail which could contribute to the comfort of their visitors. The day was one of unclouded enjoyment; the weather was a perfect specimen of an Italian spring, and Vesuvius was tranquil enough to allow the more adventurous members of the party to explore every part of the crater, only deigning to eject a few stones as Parthian arrows at the descending meteorologists.

The Congress at Rome will remain in the memory of all who took part in it as one of the pleasantest and most successful opportunities of international scientific intercourse which has ever been organised.

OUR ASTRONOMICAL COLUMN

TEMPEL'S COMET (1867 II).—The following ephemeris of this comet is deduced from M. Gautier's elements, but with the perihelion passage corrected to May 6·9537 G.M.T. to accord with the approximate position observed by Dr. Tempel on April 24:—

At Greenwich Midnight

1879.	Right Ascension. h. m. s.	Declination. ° ′	Log. distance from Earth.	Log. distance from Sun.
May 15	16 50 3	−16 17·6	9·8959	0·2487
17	— 49 15	16 36·6		
19	— 48 20	16 55·9	9·8911	0·2492
21	— 47 20	17 15·6		
23	— 46 16	17 35·8	9·8880	0·2498
25	— 45 8	17 56·3		
27	— 43 58	18 17·1	9·8866	0·2506
29	— 42 45	18 38·1		
31	— 41 31	18 59·3	9·8871	0·2515
June 2	— 40 16	19 20·6		
4	— 39 2	19 42·0	9·8895	0·2527
6	— 37 49	20 3·4		
8	— 36 38	20 24·8	9·8937	0·2539
10	— 35 29	20 46·1		
12	16 34 23	−21 7·2	9·8996	0·2554

The intensity of light is at a maximum about May 26, but is not then very materially greater than on April 24, when the comet was described by Dr. Tempel as a faint object. In 1867 it was observed at Athens until the theoretical intensity of light had diminished to 0·21, so that with the larger telescopes in the southern hemisphere observations may be possible in August. The position for August 13·5 is in R.A. 16h. 58·8m., Decl. − 29° 11′. When brightest in 1867, the nucleus was star-like and of 9·7 m., the value of I. at the time being 1·23.

During the ensuing revolution considerable perturbation may again result from the action of the planet Jupiter, though not to so great an extent as in the revolution 1867-73. Using the above time for perihelion passage in the present year and taking the mean daily motion, 593″·184, it appears that the least distance of the comet from the planet will be about 0·58 of the earth's mean distance from the sun, in the middle of October 1881, and that from the beginning of July, 1881, to the middle of January, 1882, the comet will always be within 0·65; this will again necessitate a rigorous calculation of the perturbations to insure a near prediction of the comet's track in the heavens in 1885.

It was at one time suggested that the object detected by M. Goldschmidt on May 16, 1855, while searching for De Vico's comet of short period, might have been the comet of which we are writing; but the late Dr. von Asten undertook the calculation of the perturbations backward for two revolutions from 1867, and found that the comet being in perihelion on February 1, 1856, with elements not very different from those of 1867, could not have been identical with Goldschmidt's nebulosity. So far, therefore, as is known at present, there is no recorded observation of Tempel's comet previous to April 3, 1867, notwithstanding it may have performed many earlier revolutions in the restricted orbit it now describes; but the case is similar with other comets of short period.

BRORSEN'S COMET.—Dr. Krueger has kindly sent us two meridian observations, made at Helsingfors, of the star over which Major Tupman witnessed a nearly central transit of this comet on May 3 (NATURE, vol. xx. p. 27). The star was rated 8·7 mag., and its mean position for 1875·0 was R.A. 6h. 9m. 14·84s., Decl. + 61° 28′ 8″·5. Whence the apparent position of the comet by Major Tupman's observation was on May 3, at 10h. 11m. 14s. G.M.T. in R.A., 6h. 9m. 39·15s., Decl. + 61° 28′ 30″·9, showing corrections to the ephemeris, published in this column, of + 13s. in R.A., and + 2′ in declination.

ANNUAIRE POUR L'AN 1879, PUBLIÉ PAR LE BUREAU DES LONGITUDES.—It has not been from want of appreciation of the astronomical contents of this small volume, so ably edited by M. Lœwy, that earlier allusion to it has not been found in this column. It provides information of a kind which is not to be met with in so collective a form elsewhere, and must be a valuable adjunct to the astronomical amateur, who needs reference to a really reliable authority on such details as the maxima and minima of variable stars and the general elements of the solar system, including periodical comets. M. Lœwy presents in one list the positions and limiting magnitudes of the variable stars of which the periods are known, and in a second list similar particulars of a large number of stars known to be variable, but of which the periods have not yet been determined; these lists are followed by an ephemeris of maxima and minima, arranged in order of date, with the minima of the more rapid variables, Algol, λ Tauri, S Cancri, δ Libræ, and U Coronæ. There is also a carefully-prepared list of the elements of the minor planets to No. 191 inclusive, such a catalogue, in fact, as has often been inquired for by those who do not see the *Berliner Astronomisches Jahrbuch*. The general contents of the *Annuaire* are as full and varied as usual, but for the reasons named it has now an especial value for amateurs of astronomy, and its almost nominal price places it within reach of all. M. Janssen makes an important addition in his "Notice sur les Progrès récent de la Physique solaire," which is accompanied by a photograph of a portion of the sun's disc, taken at the observatory at Meudon, June 1, 1878, illustrating the rapid transformations occurring in the photospheric network and granulations within less than an hour.

AN INTER-OCEANIC CANAL

TO-DAY the long-talked-of International Congress on the subject of a canal across the Central American Isthmus meets in Paris under the presidency of M. De Lesseps. This question is a very old one, but the movement which has led up to the present Congress commenced only in 1875, at the instigation of Lieut. Lucien N. B. Wyse, of the French Navy. At the International Congress of Geography of that year the subject of the

piercing of the American isthmus was seriously discussed. Under the presidency of M. De Lesseps an international jury was appointed to decide upon the best track and to give its opinion on the financial and economical possibility of the execution of the scheme. It was resolved to postpone the meeting of the grand jury until after the exploration of the Paya-Caquirri line. In less than a year a society of exploration was constituted, the capital subscribed, the concession of a canal obtained from the Government of Columbia, and towards the end of 1876 an expedition set out from France for the Isthmus of Darien under the command of Lieut. Wyse. From that time till a few months ago, Lieut. Wyse, with the aid of Lieut. Reclus, M. Sosa, and a staff of engineers, surveyors, &c., has been carrying on his explorations in various parts of the isthmus, so that now a vast quantity of data has been collected, and will be brought before the Congress which meets to-day. Whatever decision the Congress may come to on the immediate subject under discussion, the value of these, as well as previous explorations in connection with an inter-oceanic canal, are very great so far as our knowledge of Central America is concerned. They have added much to the scanty information we had on the physical geography, hydrography, fauna and flora of the region explored.

Not to go farther back, the first serious work of the isthmus in recent years, with a view to the construction of a canal, seems to have been undertaken by the French engineer, Napoleon Garella, who in 1843 explored the isthmus of Panama, and proposed a canal with locks and a tunnel from Simon Bay, in the Atlantic, to the Bay of Vaca de Monte, in the Pacific. But it has been the United States which, until the French Expedition, has been most earnest in the task of endeavouring to find a practicable route for such a canal, as, on the face of it, to them, in spite of their trans-continental railway, it would be of immense commercial advantage. It would reduce by more than half the sailing distance between their east and west coasts. Therefore since 1850 numerous expeditions have been sent out by the U.S. Government to

Central American Isthmus. The Longitudes are reckoned from Paris.

explore the isthmus with this view. In this way have surveying expeditions visited Nicaragua (1850), the passages between the Atrato and the Pacific, by the San Juan, the Baudo, and Cupica Bay (1850-51), the isthmus of San Blas, the narrowest part of Central America (1854), Humboldt Bay, and the Atrato, by the Truando Valley (1858-59), the Paya and the Atrato (1865). As none of these had satisfactory results, the United States Government resolved to send out a large and thoroughly equipped expedition, once for all to settle the question. For three years the expedition carried on its work, with excellent results so far as science is concerned. Tehuantepec was explored by Commodore Schufeldt, Nicaragua by Commodores Hatfield and Lull, Panama by Lull, Isthmus of San Blas, that of Darien, between the Sabana and the Bay of Caledonia, and between the Tuyra and the Atrato, by Commander Selfridge, the Atrato-Napipi by Selfridge and Collins. This expedition did not contemplate any other kind of canal than one with locks, and moreover did not examine the whole of the passage of the Paya, an affluent of the Tuyra, examined in part by M. de Lacharme in 1865. This was the state of matters when Lieut. Wyse's expedition entered upon the field, one of his chief objects being to examine thoroughly the passage from the Rio Paya to the Rio Caquirri, an affluent of the Atrato, and to discover if it were not possible to construct a canal on a level throughout, dispensing with locks, and constructing instead one or more tunnels. Lieut. Wyse and his colleague, Lieut. Reclus, point out the many advantages a level canal has over one with sluices, and by one or more of the routes they think such a canal could be constructed, and make light of the construction of a tunnel. The passages explored by Lieut. Wyse's expedition were those between the end of the Gulf of Uraba and the Gulf of San Miguel; from Acanti at the mouth of Uraba Gulf to San Miguel Gulf; from San Blas Bay to Chepillo Roads and the head of the Gulf of Panama; from Simon Bay to Panama Roads; and from Greytown to Brito Creek.

The following is a summary of the various schemes that are to be brought under the consideration of the

Congress, the numbers corresponding with those on the sketch-map which we give. The first six lie within the United States of Columbia, and the last in Nicaragua and Central America.

1. This line is in the state of Cauca, and extends from the head of the Gulf of Uraba on the Atlantic side to the bay of Chiri-Chiri. The total length between the two oceans is 290 kilometres, of which 50 are canal proper, and the rivers utilised would be the Atrato, Napipi, and Doguado. The volume of excavation would amount to 29,000,000 cubic metres, and of embankment 3,000,000. This canal would require twenty-two locks, and a tunnel six kilometres long. There are a good many objections to a canal along this line, which the American Commission placed only in the second class; besides the locks and tunnel, it would be difficult to make a good port at Chiri-Chiri. It would take nine years to make.

2. The second line is in the States of Cauca and Panama, and runs from the head of the Gulf of Uraba to Darien Harbour and the Gulf of San Miguel. It is 235 kilometres long, 128 being canal, the rivers utilised being the Atrato, Caquirri, Puquia, and Cué, or rather the Tibule, Paya, and Tuyra. It would require 22 locks and 1 kilometre of tunnel, or without a tunnel, extremely deep excavation. The material excavated would amount to 60,000,000 or 65,000,000 cubic metres, and the embankments, &c., to 6,000,000. The tertiary formation along this route presents comparatively soft rocks, and there are fine ports at the two extremities. It would take twelve years to make.

3. The third scheme is in the same State as the previous, but the line goes from Acanti at the entrance to the Gulf of Uraba, to the same Pacific terminus as No. 2, utilising the Tolo, Tiati, Tupisa, Chucunaqua, and the Tuyra. Its length would be 125 miles, of which only 74 would be canal. It would require 70,000,000 cubic metres of excavation; there would be no locks, but a tunnelling of 17 kilometres, which is a great objection, combined with the elevation of the point of departure and the difficulty of sinking shafts. It would take twelve years to make.

4. This route lies in the Chepo district of Panama State, going from the Bay of San Blas to opposite Chepillo Island, at the head of Panama Gulf. The length is fifty-three kilometres, forty-two being canal, the rivers utilised being the Nercalegua, Mamoni, and Bayano. The material excavated would amount to only 34,000,000 cubic metres, there would be no lock, but 16 kilometres of tunnel. This last point is, of course, an objection. The length of time would be ten years.

Nos. 5 and 6 are both in the Colon and Panama departments of Panama State, and, as will be seen, are to a considerable extent coincident. The former is 72 kilometres long, all canal, the River Chagres being made use of. The amount of excavation would be 57,000,000 cubic metres, and of embankment 5,000,000; there would be 25 sluices and no tunnel, and it would take six years to make. No. 6, again, would have no sluices, but tunnelling 6 kilometres long, with 47,000,000 cubic metres of excavation. It would be 75 kilometres long, and the rivers Chagres and Rio Grande would be utilised. Each would take about six years to make, and would cost about the same sum. They are near the Panama Railway, pass through a well-peopled region, and there is no difficulty as to ports. Lieut. Wyse's commission, however, advocate warmly No. 6 scheme, as being preferable to any other. The time wasted in passing locks, the difficulty and expense of maintaining them, and other considerations, induce them to advise that all idea of a canal with locks should be abandoned; and of all possible level canals with tunnels, that numbered 6 seems to this commission altogether the one presenting the most favourable conditions.

The scheme numbered 7 is in the state of Nicaragua and Costa Rica, and passes from Greytown on the Atlantic side, to the Bay of Brito on the Pacific. This line would be 292 kilometres long, 195 being canal, the San Juan, Lake Nicaragua, and the Rio Grande being utilised along the route. The excavations would amount to 48,000,000 cubic metres, and embankments, &c., to 5,500,000, and there would be twenty-one locks and no tunnel. There are too many objections to this line to attract the favourable consideration of the Congress. There are, *e.g.*, the complete absence of ports, difficulty of constructing and maintaining them, insalubrity of nearly the whole of the Atlantic slope, length of the canal, and the political instability of the countries concerned. It would take ten years to make.

As to the cost of the various schemes, we may say that it varies from 475,000,000 to 650,000,000 francs, with a yearly sum for maintenance of from 4,000,000 to 15,000,000.

Some statistics as to the dimensions proposed to be adopted for the basin of the canal may be of interest. The breadth of the canal will be about 20 metres at the bottom, 26 metres at 3 metres high, and according to the nature of the ground, from 32 metres as a minimum at the surface in deep cuttings to 50 metres, when steep banks require 2 in 1 of fall. The increase in breadth which is proposed at 3 metres above the bottom is intended to give more play to ships of large bulk and to increase the water-section, which would thus never be less than 224 square metres. The depth of the canal would be $8\frac{1}{2}$ metres. The curves proposed, with a minimum radius of 3,000 metres, are less pronounced than those in the Suez Canal. The crossing stations will have a breadth of 40 metres at the bottom on a length of 500 metres. The tunnelling will also have a depth of water of $8\frac{1}{2}$ metres, a breadth of 20 metres at bottom, but only 24 at the surface. The smallest water-section will thus be 187 square metres. Above the mean level, on each side, there will be a straight space of 4 metres, then an arch of 30° in a radius of 63 metres; the summit will be semicircular, with a radius of only 2 metres. To satisfy all contingencies the height of the vault above the level of the water will reach 34 metres, which will allow the largest vessels to pass by a little adjustment of their most prominent masts and yards. The entire subterranean section will be 780 square metres, of which 563 will be above water. It is expected that throughout, very little embanking will be necessary.

Thus, so far as the International Commission is concerned, the information to be laid before the conference is full and exact. So far as we have studied the question there seems no serious physical or engineering difficulty in cutting a canal through the American isthmus between the Atlantic and Pacific; probably the great difficulty will be a monetary one, and even this need not, we suppose, be insuperable, if all other difficulties are removed.

ON THE EVOLUTION OF THE VERTEBRATA[1]

II.

AMPHIBIA (*continued*).—When the history of the development of these forms has been thoroughly made out, the terminology can be put into something like proper form. This will have to be done cautiously, for that which we see as one bone in the larva represents, and may become, two or three bones in the adult, and these may represent bones that start as distinct centres in the higher forms.

In the Urodeles there is one bone (the *pterygo-palatine*) in the larva which plays many parts during metamorphosis, and a different part in different species. At first it is related to no cartilage at all, only arising as a cement to a patch of palatine teeth, but after a time the ethmo-

[1] Abstract of Prof. Parker's Hunterian Lectures, delivered at the College of Surgeons, commencing on February 10. Continued from p. 32.

palatine and pterygoid cartilages appear, and it then subdivides, the pterygoid getting the larger half but no teeth, and the ethmo-palatine the lesser half and all the teeth. The form of these parts varies much in the different genera.

The apparent uniformity of the Batrachia, as to the skull especially, is quite belied by what is found on dissection. The disposition of parts in the skull varies greatly.

A careful study of the morphology of the Batrachia suggests many things as to their genetic origin, and accords very accurately with the known facts of their geographical distribution. On the whole the types are more generalised in the west than in the east, and much more so in the south than in the north.

There is nothing in which the frogs and toads differ more from the salamanders than the extraordinary development of the middle ear; the latter always modify a part of the capsule so as to produce a fenestra ovalis and stapes: but in the former, as a rule, the upper element of the hyoid arch is modified into the chain of the middle ear, the spiracular cartilage into the ring of the ear-parchment, and the skin covering the first cleft into the parchment of the ear drum. In certain kinds of frogs and toads these parts are as much arrested as in the salamanders and newts; in all of them that part of

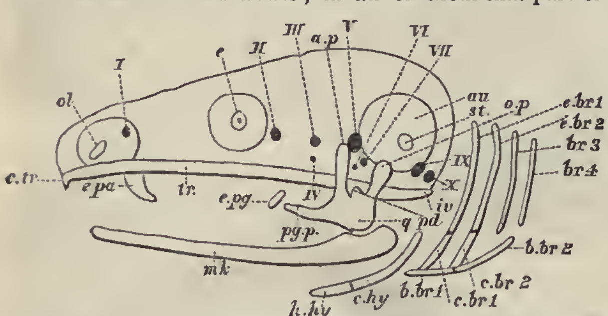


FIG. 2.—Diagram of chondrocranium of young Axolotl. The Roman figures indicate the nerve foramina. *a.p*, ascending process of suspensorium; *au*, auditory capsule; *b.br*, basi-branchial; *br*, branchial arch; *c.br*, cerato-branchial; *c.hy*, cerato-hyal; *c.tr*, coruna trabeculæ; *e*, eye; *e.br*, epi-branchial; *e.hy*, epi-hyal; *e.pa*, ethmo-palatine; *e.pg*, epi-pterygoid; *iv*, investing mass; *mk*, Meckel's cartilage; *ol*, olfactory capsule; *o p*, orbital process; *pd*, pedicle; *q*, quadrate; *st*, stapes; *tr*, trabeculæ.

the hyoid arch which is developed into the middle ear-chain is later in its appearance than that which carries the tongue.

It is evident that the great polymorphism of these types is due to the influence of their surroundings upon them.

The larger kinds are a long while undergoing metamorphosis, and in their adult condition they possess many bones which can only be found again in the long-extinct Amphibians of the Coal Measures. With regard to small and arrested kinds, which, as a rule, belong to the Notogœa, their arrest in metamorphosis can be paralleled with various stages of development in higher kinds. For example, in *Pseudophryne bibronii*, a small Australian bombinator toad, the auditory apparatus is arrested at the same stage in which we find it in our native kind up to midsummer, that is to say, there is no columella; in *Rhinoderma darwinii*, a South American form, the columella is a thick short wedge of cartilage terminating externally in a fibrous thread, precisely like the rudiment we find in our own native kinds in the beginning of July; and in a small African species of frog, *Gomphobutes*, the columella is developed to the condition of that of our native kinds a month or two later, and it is not ossified.

The relative size of the perfect larva to the adult is extremely variable in the Batrachia. In *Bufo chilensis* the recently metamorphosed young is no larger than a common house-fly, the tadpole being about twice the size, and in *Pseudis paradoxa*, a South American form, which is scarcely larger than our native frog, the tadpole attains the size of a herring or a red mullet. In the case of *Pipa monstrosa* from Surinam, the young when ready to leave the dorsal pouches of the mother are scarcely as large as a honey-bee, but as perfect in their metamorphosis as the young of our native frog and toad at the end of a year; the mother toad is twice as large as a large female native toad.

It is evident that those forms in which the tadpole is of such a large size, have a tendency to remain in the larval condition, and are thus a little in advance of the axolotl, most of the individuals of which are arrested as permanent larvæ, a few only undergoing transformation into true gill-less salamanders (*Amblystoma*).

The manner in which the different kinds of Batrachia are modified, both as to their outward form and skeleton, each one to suit its own particular kind of life, is very interesting and instructive. The little tree-frogs have in their skull a large membranous fontanelle, covered merely with skin, as in young infants; their toes are flattened, and thus they are able to climb with ease and safety amongst the foliage, the colours of which they imitate. Other forms, such as *Pelobates fuscus*, living on the ground, have their small brain encased in dense and almost enamelled armour, and besides this protection, the above-mentioned *Pelobates*, or garlic toad, has the power of giving forth an offensive odour from the skin. This last kind is almost devoid of a middle ear, and the columella is extremely small; the little tree-frogs, on the contrary, have very perfect ears. Thus in *Pelobates* we have a skull approaching that of the Labyrinthodonts, while in the tree-frogs the skull resembles very much that of a shark or skate.

Some large kinds, such as *Ceratophrys dorsata*, have, besides the dense bony plates covering the head, similar large scutes over their shoulders.

The frogs and toads that possess a tongue have their eustachian passages wide apart, as in Mammals, but in the tongueless forms, *Pipa* and *Dactylethra*, the two tubes meet at the mid line, as in birds. They have all two separate occipital condyles, as in Mammals.

Taking the Batrachia through and through, they form a wonderfully perfect chain of types; they do not, however, lead us directly to any existing groups of high Vertebrates, but rather look towards Mammalia than in the direction of reptiles and birds.[1]

REPTILES

Snakes.—The snakes have probably arisen from ancestors which possessed limbs, which, however, have become inconvenient to their descendants, and have therefore been supressed. The boas and pythons, as well as the *Typhlopidæ* and *Tortrices*, have, however, rudiments of posterior extremities.

There is a certain embryonic simplicity in the internal skull, but the outer skull is very perfect and marvellously specialised, as is also the spine. There are no exoskeletal elements whatever behind the head, but in the head there are some small cartilages besides the investing bones, which latter form three-fourths of the skull.

The bones of the skull are the most adamantine to be found anywhere in the vertebrate kingdom, while the cartilage, where it survives (as in the *trabeculæ*), is perfectly elastic, and untouched by the ossifying process. Where sutures persist they are perfectly distinct to old age; when ankylosis takes place along any particular line it early obliterates the least trace of the original suture.

A large part of the base of the skull is more simple and embryonic than anything to be seen in the skull of the

[1] Besides the two papers in the *Philosophical Transactions* (1871 and 1876), the lecturer is preparing a large memoir on the structure and development of the skull in a large number of larval and adult forms of Batrachia.

adult lamprey, while other parts are as much specialised as anything that can be found in the skull and face of a man. There are no *dermostoses*, and no instance is known in which a splint bone (*parostosis*) unites with any part of the ossified endocranium, except in the base of the skull, where a rostrum of membranous origin unites with the basisphenoid. The skull is largely formed of splint bones, and the inner parts of the face are also formed of membrane bones, which, however, represent cartilaginous elements in fishes. The outer parts of the face are formed of bones that have no cartilaginous representatives in the lower forms, but exist as splint bones or dermal scutes in the Ganoids, osseous fishes, and Amphibia. So that in a mere study of the development of the snake, without reference to other types, we should find no difference between the premaxillaries and the maxillaries on the one hand, and the palatines and the pterygoids on the other.

The whole apparatus of the palate and upper and lower jaws is a very loosely articulated structure, and each bone is kept as much as possible in the form of a simple bar or splint.

The hinder part of the endocranium and the auditory capsules are intensely ossified, and contrary to what is seen in any other vertebrata, the orbito- and ali-sphenoids are separately developed in the membranous walls of the skull; they are both very small, especially the former. The three bony elements of the auditory capsule remain permanently separate, but the pro-otic unites with the ali-sphenoid, the epi-otic with the supra-occipital, and the opisthotic with the ex-occipital.

The only visceral elements that are developed behind the mandible are the rod of the columella and the minute stylo-hyal which coalesces with the quadrate.

Lizards.—The lizards form a very large group of reptiles, all of which, like the snakes, have a movable pier to the lower jaw, but which have a very remarkable diversity of external and internal characters. Besides the typical lizards, this order includes the Amphisbænæ, the blind-worms, the chamæleons, and the New Zealand *Hatteria* (*Sphenodon*).

For practical zoology, all that can be seen and handled in an animal without dissection is, of course, readiest and best for classification, but to establish a sound foundation, it is necessary to go much deeper. The brain, heart, and other internal organs present very poor distinctive characters in the families under consideration when compared witn the skull, face, spine, and limbs.

In the most serpentiform of lizards there are at least limb girdles even if there are no limbs.

In several kinds, such as the Blind-worms (*Anguis fragilis*) and the Australian *Cyclodonts*, there is a dermal scute inside each horny scale. In the latter and also in the Skinks (*Mocoa*), the underlying parietals and frontals are extensively ankylosed to the overlying bony scutes. In our native sand-lizards the investing bones that lie next the skin, where there are no intervening muscular fibres, become rough and thick, like ordinary dermal scutes; the horny skin over them is thin and has no bony plates under it as in the body. In the larger number of lizards, including the blind-worms, the three normal ventral splint-bones—a pair and an odd one—are seen; in *Hatteria* these are continued along the abdomen segmentally, as in the Plesiosaurs. These bones are suppressed in the chamæleon, which deserves to represent a sub-order by itself, so little has it conformed to the normal type of the lizard.

In the chamæleon the outer bones of the head become crested, scabrous, and fretted with all sorts of markings. In such types as *Monitor*, *Stellio*, and *Iguana*, the cranial roof-bones and the bones of the face are not rough, as in the sand-lizard, nor fretted, as in the chamæleon, but smooth, as in the serpents and birds.

One of the most remarkable things in the skull of some of the types is the retention of rows of bones the counterparts of which must be sought for in the ancient Amphibia of the Coal Measures and in the still more ancient Ganoid fishes of the Old Red Sandstone. In the little nimble lizard, for example, we have two rows of such bones strengthening the eyebrows, and another row over the temporal region, besides a bone flooring the outer nostril, which belongs to the same category.

A sort of anticipation of the hinge of the bird's upper jaw is seen in the sand lizard and in the large stump-tailed lizard of Australia (*Trachydosaurus rugosus*), in which forms a fenestra appears in the orbito-nasal septum. This does not appear in the ostrich tribe, but begins in the Tinamous. Considered evolutionally, this is an exceedingly interesting and instructive fact.

The parietals, which are simply roof-bones, are propped up by a slender rod of bone, the so-called *columella* (*epipterygoid*), which must not be confounded with the bone of the same name in the middle ear. The chamæleons, however, do not possess this bone, and they are also deficient in respect of their ear, having neither the drum and its parchment nor any rudiment of a cochlea.

There is usually only one premaxillary, but in the Skinks and Cyclodonts there are two.

When the birds are spoken of as being genetically related to the lizards, it must be understood that *modern* lizards are not referred to; they are in many respects as

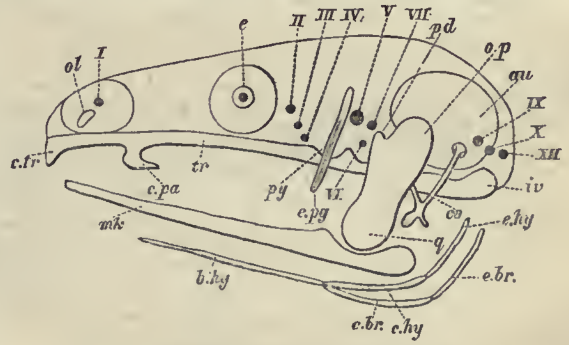


FIG. 3.—Diagram of chondrocranium of Lizard. Letters as before. *b.hy*, basi-hyal; *co*, columella; *py*, pituitary space.

much specialised as the birds themselves, and only form a *side branch*, and not a *leader* of the vertebrate life-tree.

Chelonia (*Turtles and Tortoises*).—The extinction of old, irregular, generalised tortoises has left their descendants in a very neat and orderly state, showing a great uniformity and distinctness from the other reptiles, in the fact that the body is inclosed in a strong bony box formed of the carapace and plastron.

This box is formed of bony plates, covered with horny scales, which, however, do not conform to them. The inner skeleton in the walls and roof of this curious building has become fused with the outer; below there is no inner skeleton, these animals having neither sternum nor sternal ribs, the plastron and the marginal plates of the carapace being formed by ossifications in the dermis. The carapace is principally formed by the bony matter from the spines of the back and of the rib-shafts spreading into the thick overlying web of fibrous tissue.

In some of the Mud Tortoises the edges of the carapace are often soft, and the plastron is very imperfect. In *Chelydra* and the *Matamata* the neck and tail are much longer than usual, and remind the observer of the Plesiosaurs.

The plastron is formed of four bones on each side, the anterior pair being separated by a single median piece, and thus only one of the median ventral bones of a Plesiosaurus or Hatteria is retained.

There are no teeth, the jaws being covered with horn, and forming an efficient shearing apparatus. The facial

bones are few and expanded; the nasals, pre-frontals, and lacrymals are represented by a single bone, and there are no superorbitals. There is no *second* temporal bone, as in lizards, but an additional cheek-bone, the *quadrato-jugal*, unites the jugal to the pier of the lower jaw, a very exceptional thing in lizards (*e.g.*, *Hatteria*.)

The large investing bones have to a great extent aborted the proper internal skull; this is especially the case between the capsules of the ears and the labyrinths of the nose.

In the logger-head and green turtles the cranial compartment has a "shed" or "lean-to" on each side, formed by the parietals, post-orbitals, and squamosals. The pterygoids form the greater part of the bony floor of the skull, between which and the descending wall there is a little bony "prop" corresponding to the *columella* (*epipterygoid*) of the lizard.

The mandible has no *splenial* element, as in bony fishes and frogs. There are two arches developed behind the mandible—the hyoid, or tongue arch, and a second, corresponding to the first gill arch in fishes and Amphibia. The pier of the arch of the lower jaw (*quadrate*) is hollowed into a drum, over which is stretched its "opercular fold," as the parchment, in which there is an annular cartilage. The pier of the tongue-arch is a long slender rod, the *columella*, the proximal part of which answers to the stapes, and the rest to the incus; it stretches between the *fenestra ovalis* and the drum membrane.

This peculiar hollowing out of the quadrate is a promise of the air-cells seen in many of the bones of birds.

The development of the embryo of the Chelonia takes place in essentially the same manner as in birds; yet, in the young of the green turtle, half an inch long, the rudiments of the carapace can be seen.

The parental form of all the modern Chelonia was probably intermediate between the extinct *Rhynchosauria* and the *Plesiosauria*, and the existence in the Cape toad (Dactylethra) of characters that correspond very closely with those of the Chelonia, suggests a relationship between certain ancient forms of the Batrachia and the generalised types from which the Chelonia have sprung.

(*To be continued.*)

GEOGRAPHICAL NOTES

IT would appear as if the War Office authorities expected the special service officers who are on the point of starting for Zululand to find opportunities for doing useful geographical work in that country, as we understand that the Intelligence Department are supplying them with the most recent edition of "Hints to Travellers," published under the authority of the Council of the Royal Geographical Society, and edited by Mr. Francis Galton, F.R.S.

THE news of the death of the Marquis Antinori, the leader of the Italian Expedition to Central Africa, is, we are glad to say, contradicted.

THE Congress of Commercial Geography, to be held at Brussels in September, will be presided over, not by M. Bamps, but by Lieut.-General Liagre, president of the Belgian Geographical Society and perpetual secretary of the Belgian Academy of Sciences. M. du Fief will act as secretary.

NEWS from Leipzig states that the president of the Meteorological Office of that city, Baron A. von Danckelmann has been invited by M. Sibiriakoff to take part in the expedition to the Siberian Arctic Sea, and that he has accepted the invitation, the necessary permission having been readily granted to him by the Saxon Government. The expedition was to sail on May 14.

Les Missions Catholiques publishes an interesting communication from Père Gourdin, a missionary in the Chinese province of Szechuen, in which he gives an account of the little-known tract of country in the south of the province, called Kienchang.

THE last report of Her Majesty's Consul at Newchwang contains much information in regard to Manchuria which is of interest from the standpoint of commercial geography. There are reasons for believing, in his opinion, that in spite of the watershed between the valleys of the Liao and the Sungari, Newchwang will successfully compete with Nicholayesk for the most valuable part of the trade with the latter valley, and those of the two great affluents of the Sungari, the Nonni and the Hurka. A great point in its favour is that the Liao River is remarkably easy of access, while the navigation of the Amur at its entrance is extremely intricate, and is closed by ice for seven months in the year. Colonisation, we are told, is proceeding in the valley of the Yalu-Kiang, the boundary between China and Corea. With regard to the production of opium in regions at a distance from Newchwang, Mr. Consul Adkins says that it is growing in most parts of the province of Fêngtien (South Manchuria), in many parts of the Kirin province, and in a daily increasing area in the southern portion of Eastern Mongolia, notably in the tract of country which lies on the right bank of the Sungari in the angle formed by the reaches of that river above and below its junction with the Nonni, east and south-east of Petuna.

A FURTHER instalment of the *Transactions* of the Asiatic Society of Japan, which has just come to hand, contains some interesting notes of a visit paid last year to the little-known island of Hachijô by Mr. F. V. Dickens and Mr. Ernest Satow, the Japanese Secretary of H.M.'s Legation at Yedo. The island in question, it may be useful to note, is erroneously called Fatsizio on our Admiralty chart; it is the last but one of the chain which extends south of the promontory of Iazu in almost a straight line.

IN a brief account of the work of the China Inland Mission in Burmah we find some notes of interest respecting a visit to the Kah-chen hills near the Chinese frontier. The village visited is situated among the mountains at an elevation of 4,000 feet above the Burmese town of Tsee-kaw. The Kah-chen houses are described as being built of bamboo, and more substantially than those of the Burmese. The roof of each is about 100 or 150 feet in length; at the entrance for some 15 feet the sides are open or merely formed of open bamboo work. The poles which support the roof of this part of the building are ornamented with the heads and horns of buffaloes sacrificed to the *nats* or spirits. On either side of a long passage are small rooms, the first of which is the guest chamber; the kitchen and general sitting-room is at the end of the passage, whence a door, always open, leads into a small raised veranda and which is entirely appropriated to the use of the *nats*, of whom the people are in great dread. The dress of the women is superior to that of their Burmese sisters, than whom they are said to be more modest. All who can afford it, wear a large silver hoop round the neck, and as many strings of red, green, blue, and white beads as they can muster. Their ear ornaments are peculiar; large flaps of ornamented cotton hang from the back of the ear, and tassels or silver tubes are passed through the lobes. All wear large coils of rattan round their bodies, and the younger ones wear bells and cowrie shells. There is, however, one objection to both men and women, viz., their great want of cleanliness.

NOTES

THE University of Edinburgh has sustained a great loss in the unexpected death of its veteran and genial professor of mathematics. Only three weeks ago, in giving the annual address at the graduation ceremonial, he in touching terms

alluded to his long length of service, and the improbability of his again addressing the collected body of graduates. The labours of the winter session had proved too much for his enfeebled health. Immediately after their close he left for the country, where he seemed at first to revive, but a cold which he caught brought on congestion of the lungs, against which he had not strength to rally. He died on the 7th inst. His eminence as a mathematician, and his excellence as a teacher, combined with his admirable personal qualities, will be long remembered by all who have known the Edinburgh University during the last forty years.

THE death is announced of Prof. Grisebach, the well-known botanist and geographer. He was born in 1814 at Hanover, and in 1841 was called as Professor of Botany to Göttingen, where he was still officiating up to his death. He contracted his illness while on a visit with his family to Italy.

M. PASTEUR is about to found, in the department of the Jura, with the support of the French Minister of Agriculture and Commerce, who has for this purpose granted a subvention of 1,000*l*., a special laboratory for the study of all questions connected with the vine and wine. This laboratory, provided with all the means of investigation which bear on researches of this nature, will be located at Arbois, and M. Pasteur will devote six months each year to it. Important results may justly be looked for from this institution.

THE Baly Medal of the Royal College of Physicians of London has been awarded to Mr. Chas. Darwin, F.R.S.

HERR KARL BOCK, who, at the request of the late Marquis of Tweeddale, has spent eight months in exploring the highlands of Sumatra, has, the *Times* states, returned to Padang with a rich collection of natural history specimens. Among other living animals he has secured a specimen of the *Capricornis sumatrensis*, which is peculiar to the island. It is a species of mountain antelope, rarely met with, and only among the most remote and almost inaccessible peaks. Herr Bock was travelling in Lapland in the autumn of 1877, under the 71st parallel of north latitude. The autumn of 1878 was spent by him under the first parallel of south latitude.

A SERIES of "Davis" lectures upon zoological subjects will be given in the lecture-room of the Zoological Gardens, in the Regent's Park, on Thursdays at 5 P.M. The first was given last Thursday by Prof. Flower, on "Birds that do not Fly." The others are as follow:—May 15, "The Pleasures of Zoology," Prof. J. Reay Greene, M.D.; May 22, "Tails," Prof. Mivart, F.R.S.; May 29, "Parrots," P. L. Sclater, F.R.S.; June 5, "Snakes," Prof. Huxley, F.R.S.,; June 12, "Nocturnal Animals," Dr. J. Murie, LL.D., F.L.S.; June 19, "Reptiles and their Distribution," P. L. Sclater, F.R.S. These lectures will be free to Fellows of the Society and their friends, and to other visitors to the Gardens.

MR. ORVILLE A. DERBY contributes to the *Rio News* some interesting information on the plague of rats in Brazil. From time to time in all parts of Brazil the plantations are subject to the depredations of armies of rats that issue from the forests and consume everything edible that comes in their way. During a recent excursion in the province of Paraná Mr. Derby found an almost universal lack of corn throughout the province, due to such invasion of rats, by which almost the entire crop of last year had been destroyed. This invasion, or plague as it is called, is said to occur at intervals of about thirty years, and to be simultaneous with the drying of the *taquara*, or bamboo, which everywhere abounds in the Brazilian forests. The popular explanation is that every cane of bamboo sprouts with a grub, the germ of a rat, within it, and that when the bamboo ripens and dies the germ becomes a fully-developed rat and comes out to prey on the plantations. An educated and observant Englishman, Mr. Herbert H. Mercer, who has resided a number of years in the province and had an opportunity of studying the phenomenon, furnished Mr. Derby the following rational and curious explanation:—The bamboo arrives at maturity, flowers and seeds at intervals of several years, which doubtless vary with the different species. The period for the species most abundant in Paraná is thirty years. The process, instead of being simultaneous, occupies about five years, a few of the canes going to seed the first year, an increased number the second, and so on progressively, till finally the remaining and larger portion of the canes seed at the same time. Each cane bears about a peck of edible seed, resembling rice, which is very fat and nourishing, and is often eaten by the Indians. The quantity produced is enormous, and large areas are often covered to a depth of five or six inches. After seeding the cane dies, breaks off at the root and falls to the ground, the process of decay being hastened by the borings of larva which live upon the bamboo and appear to be particularly abundant at seeding time. These larva have doubtless given rise to the story of the grub developing into a rat. New canes spring up from the seed, but require seven or eight years to become fit for use, and thirty to reach maturity. With this sudden and constantly increasing supply of nourishing food for a period of five years, the rats and mice, both of native and imported species, increase extraordinarily in numbers. The fecundity of these animals is well known, and the result after four or five years of an unusual and constantly increasing supply of excellent food and in the absence of enemies of equal fecundity, can readily be imagined. The last of the crop of seed being mature and fallen to the ground, the first rain causes it to decay in the space of a very few days. The rats, suddenly deprived of food, commence to migrate, invading the plantations and houses and consuming everything that does not happen to be repugnant to the not very fastidious palate of a famishing rodent. If this happens at the time of corn planting, the seed is consumed as fast as it can be put into the ground. Mr. Mercer, who plants annually about fifty acres of corn, replanted six times last year, and finally gave up in despair. The mandioca is dug up; the rice crop, if it happens to be newly sown or in seed, is consumed, as is also everything in the houses in the way of provisions and leather, if not carefully guarded in tin trunks.

THE Congress of the Social Science Association at Manchester has been fixed to take place from October 1 to 8.

Deutsche Acclimatisation is the title of a new German journal devoted to questions connected with the acclimatisation, training, and breeding of birds. It is the organ of the German Society for the Breeding and Acclimatisation of Birds, and will appear at irregular intervals. The editor is Dr. Reichenow.

THE cryptogamous division of the herbarium of the Boston (U.S) Society of Natural History, we learn from the *American Naturalist*, has been enriched by the discovery of a valuable collection of lichens. This was formerly the lichen-herbarium of Dr. Thomas Tayler, an Irish botanist, to whom Sir W. J. and Sir Joseph Hooker gave the whole of their extensive collection of lichens, gathered during many exploring expeditions. Dr. Tayler published descriptions of these plants in the *Journa of Botany*, 1844–66, and many of the specimens are the originals of the descriptions. In 1850 Mr. John A. Lowell purchased the collection from Dr. Tayler's heirs, and it formed a part of the herbarium subsequently presented by him to the Society.

THE following (*ben trovato*, if not the other thing), seems worth reproducing from *Science News*:—It is not long ago that a young man went to one of the wise men at the Smithsonian Institution, and said: "I think I should like to be a naturalist." "Well, *be* one," replied the doctor in charge. "But I don't know how,

and wish you would get me rightly at work at the start." "Very well," said the willing master, "there is plenty to be done right here; let us begin on these fishes." Turning to a can of fishes from Arizona in spirits, he opened the cover, pulled up his sleeve, and brought forth two or three dripping examples. They were well preserved, but the smell—well, the less said about that the better; it was very "ancient" and somewhat "fish-like." "There, see what more you can get out of that can, and I'll show you what to do next." The young man paused in dismay and tugged very gently at his kid glove. Finally, in deprecating tones he asked: "Doctor, is it necessary, in order to become a naturalist, that I plunge my hands in that alcohol?" "Of course—no other way to study objects of natural history properly, except in the field." "Well," was the reply, very decided, albeit somewhat rueful, "I—I think I'll go back to Long Branch." And go back he did.

Dr. Hopkinson gave important evidence before the Electric Lighting Committee last Friday. As a result of his experiments, he found that on an average about 87 per cent. of the mechanical energy bestowed on the machine was converted into heat, but about 50 per cent. of the electricity obtained from the mechanical energy was lost in the heating of the machine and wires. The scientific considerations, he stated, had largely been touched in a satisfactory manner. Mr. Shoolbred, of the firm of Shoolbred and Co., Tottenham Court Road, gave satisfactory evidence of the working of the light in his establishment. He was burning twenty candles, which had replaced 230 gas burners. The cost to him was 37*s.* 3*d.* per night in winter, and 9*s.* 10*d.* in summer.

The American papers state that Mr. Edison is still engaged in his experiments with reference to the electric light, and hopes yet to overcome all difficulties, and to make the light available for public use. He intends to institute a comparative trial on carbon lamps between his own machine and those of Wallace and Gramme; he does not say how many carbon lamps he can light with his machine. He is confident that he can work his system for street and house-lighting with comparatively little loss by exhaustion of the current, by means of a cable, from a central station, the cable composed of as many strands of wire, say one-sixteenth inch diameter, as there are houses in the street to be lighted. The latest papers say that Mr. Edison has perfected his dynamo-electric machine, and with that he maintains he has solved the problem of the economical generation of electricity and the sub-division of the light. A trial of his system is stated to have worked perfectly, producing more lights and less heat with less expenditure of power than any machine hitherto constructed.

The Meudon Aërostatic Service officers are constructing a directing balloon with screw moved by a steam-engine. They have desisted from their original scheme, which was to attach the screw to the equator of the balloon, and have acknowledged reluctantly the necessity of adopting the principles used by M. Henry Giffard, in his celebrated 1852 hippodrome experiment with a steam directing aërostat.

According to official statistics 22,851 wild animals and 127,295 serpents were destroyed in India during 1877; while 16,777 persons died from the bites of serpents, and 2,918 were killed by tigers, leopards, wolves, and other wild animals.

Akhbar, the most influential French paper in Algeria, is devoting many interesting articles to the construction of the Trans-Saharan railway from Laghouat to Timbuktu through Touat. The preliminary surveys have been executed from the Algiers-Oran line to Laghouat.

The last number of the Russian Physical and Chemical Society's *Journal* (vol. xi. fasc. 3) contains the annual reports of the Society, and papers on the temperatures of boiling of saturated hydrocarbons of normal structure, by M. J. Goldstein; on benzoic compounds, by M. P. Goloubeff; on aromatic compounds, by M. E. Wroblevsky; and on the transmission of a galvanic current in water when the platina electrodes are of various sizes, by M. Slouginoff.

In a recently-published inaugural dissertation on the electromotive forces which occur in free water jets (*Ann. der Phys.*, No. 4), Herr Elster arrives at these conclusions:—1. A liquid motion *per se* produces no electromotive force. (This is against Edlund's view). 2. Capillary electric currents are simply produced by friction of the particles of the moved liquid; in the case of non-wetting liquids, by their friction on the particles of the solid wall, and in the case of wetting liquids, by friction on the particles of a layer of the liquid condensed on the surface of the solid, this layer behaving to the less dense as a heterogeneous substance. 3. The capillary electric currents discovered by Quincke are identical with the friction-currents which occur in the rubber of an electric machine, and which were first observed by Zöllner. Numerous experiments in support of these conclusions are described.

News has been received from Japan that two very rich seams of coal have just been discovered in the celebrated Takashima mines. It is estimated that they will produce fully a million tons of coal. It is also reported that active measures are being taken for throwing open to foreign commerce the ports of Tsuruga and Shimonoseki.

The first of two illustrated volumes, on the Manufacture of Sulphuric Acid and Alkalis, by Prof. Lunge, of Zurich, will be published in a few days by Mr. Van Voorst, who has also just ready for publication a supplement to C. Greville Williams's "Handbook of Chemical Manipulation."

The fourth public annual meeting of the Sunday Society will be held in Freemasons' Tavern on Saturday, at 4 P.M. From their just published Report we see that the Society is making marked progress in the objects which they have in view.

The supplement to the *Colonies and India* for May 10 contains a long address given to the Colonial Institute by Prof. Owen on the Extinct Animals of the Colonies of Great Britain.

We have received a most interesting and instructive lecture on Ornithology, by Dr. H. B. Hewetson, of Leeds; its title is "Nature Cared for and Nature Uncared for, the Result upon the Hearts of Men." He tries to show how much pure pleasure can be derived from the observation of living nature, and the study not of the dead animal, but of "the life-sympathies and instincts of the object in life." The lecture deserves a wide circulation. The publishers are West, Newman, and Co., of London.

The additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. C. A. Thomson; an Ocelot (*Felis pardalis*) from America, presented by Mr. P. Leckie; an Indian Kite (*Milvus govinda*) from East Asia, presented by Capt. Murray; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. A. Dodd; a Diana Monkey (*Cercopithecus diana*), a Subcylindrical Hornbill (*Buceros subcylindricus*) from West Africa, received in exchange; a Macaque Monkey (*Macacus cynomolgus*) from India, five Peacock Pheasants (*Polyplectron chinquis*) from Burmah, deposited; twelve Common Teal (*Querquedula crecca*), twelve Garganey Teal (*Querquedula circia*), twelve Red-headed Pochards (*Fuligula ferina*), six Tufted Ducks (*Fuligula cristata*), four Shovellers (*Spatula clypeata*), two Common Pintails (*Dafila acuta*), two Common Widgeons (*Mareca penelope*), European, purchased; an Hybrid Markhoor (*Capra megaceros*), six Seven-banded Snakes (*Tropidonotus leberis*), born in the Gardens.

RECENT CONTRIBUTIONS TO THE HISTORY OF DETONATING AGENTS[1]

III.

NOBEL has observed that if, instead of making use of the most explosive form of gun-cotton, or trinitrocellulose, a lower product of nitration of cellulose (the so-called soluble or collodion gun-cotton) is added to nitro-glycerine, the liquid exerts a peculiar solvent action upon it, the fibrous material becoming gelatinised while the nitro-glycerine becomes at the same time fixed, the two substances furnishing a product having almost the characters of a compound. By macerating only from 7 to 10 per cent. of soluble gun-cotton with 90 to 93 per cent. of nitro-glycerine, the whole becomes converted into an adhesive plastic material, more gummy than gelatinous in character, from which, if it be prepared with sufficient care, no nitro-glycerine will separate even by its exposure to heat in contact with bibulous paper, or by its prolonged immersion in water, the components being not easily susceptible of separation, even through the agency of a solvent of both. As the nitro-glycerine is only diluted with a small proportion of a solidifying agent which is itself an explosive (though a somewhat feeble one), this *blasting gelatine*, as Nobel has called it, is more powerful not only than dynamite, but also than the mixture of a smaller quantity of nitro-glycerine with the most explosive gun-cotton, as the liquid substance is decidedly the most violent explosive of the two. Moreover, as nitro-glycerine contains a small amount of oxygen in excess of that required for the *perfect* oxidation of its carbon and hydrogen constituents, while the soluble gun-cotton is deficient in the requisite oxygen for its complete transformation into thoroughly oxidised products, the result of an incoporation of the latter in small proportion with nitro-glycerine, is the production of an explosive agent which contains the proportion of oxygen requisite for the development of the maximum of chemical energy by the complete burning of the carbon and hydrogen, and hence this blasting gelatine should, theoretically, be even slightly more powerful as an explosive agent than pure nitro-glycerine.

That such is the case has been well established by numerous experiments, but although this blasting gelatine may be detonated like dynamite by means of small quantities of confined detonating composition, when it is employed in strongly-tamped blast-holes, or under conditions very favourable to the development of great initial pressure, it behaves very differently from that material, or other solid though plastic preparations of nitro-glycerine, if the attempt is made to detonate it when freely exposed to the air or only partially confined. It not only needs a much more considerable amount of strongly confined detonating composition than dynamite and similar preparations do, to bring about a detonation with it under those conditions; but when as much as fifteen or twenty grains of confined fulminate are detonated in direct contact with it, although a sharp explosion occurs, little or no destructive action results, and a considerable portion of the charge operated upon is dispersed in a finely-divided condition.

In comparing the effects of these nitro-glycerine preparations with each other and with compressed gun-cotton and preparations of it, by detonating equal quantities quite unconfined upon iron plates, the results appear to establish great superiority, in point of violence, of action, or destructive effect, of the more rigid explosive agents (the gun-cotton preparations). Thus, employing iron plates 1 inch thick (supported upon an anvil with a central cavity), and 4 oz. of each material unconfined, the charges being all about the same diameter, exploded by detonators of equal strength, and simply resting upon the upper surface of the plate, compressed gun-cotton produced a considerable indentation of the upper surface of the plate, and long cracks in the lower surface; a species of nitrated gun-cotton, called tonite, produced a much shallower indentation, though still a very marked one, but did not crack the lower surface. Dynamite produced only a very slight impression upon the plate, and none could be detected by the eye on the plate upon which the blasting gelatine was exploded. The difficulties, brought out by past experience, which attend the contrivance of really comparative tests of the explosive power of such substances as those under discussion, is well exemplified by the foregoing results, which were influenced to the maximum extent by the physical characters of the several substances when thus applied, in a perfectly unconfined condition, so that the particles were free to yield to the force of the initiative detonation in proportion to their mobility. But, for this very reason, these experiments afford excellent illustration of the extent to which the development of detonation and the sharpness of its transmission through the mass is influenced not only by the inherent sensitiveness of the substance to detonation, but also by the degree of proneness of their particles to yield mechanically to the force of a blow as applied by an initiative detonation. Thus, although in comparing two substances of similar physical characters, compressed gun-cotton and compressed nitrated gun-cotton or tonite, the superiority of the pure compound over the mixture, in point of sharpness and violence of action, is well illustrated, a comparison of the result furnished by the weakest of the four explosive agents tried, viz., tonite, with that of the substance which should be superior to all the others in explosive force (*i.e.* the blasting gelatine) demonstrates the important influence which the comparatively great rigidity of the mass in the one case exerts in favouring the completeness and sharpness of its detonation in open air, and the great disadvantage under which the other explosive is applied, arising out of the plastic and therefore readily yielding nature of the material. But if, by exposure to a moderate degree of cold, this plastic nitro-glycerine preparation is made to freeze, its detonation upon an iron plate produces an indentation, as well as a destructive effect upon the lower surface of the plate, very decidedly greater than those furnished by the corresponding amount of pure compressed gun cotton. Similarly, the effect produced by the detonation of dynamite upon a plate of the kind used, is but little inferior to that of gun-cotton, and decidedly greater than that of tonite, if it is employed in the frozen condition.

A series of experiments has been made with cylinders of lead having a central perforation 1·3 inch in diameter extending to a depth of 7 inches and leaving solid metal beneath of a thickness ranging from 3·5 to 5·5 inches, according to the size of the cylinders used. These furnished results of considerable interest as illustrating the action of these several detonating agents. Charges of 1·25 oz. of each explosive substance were used throughout the experiments, and were placed at the bottoms of the holes. By the detonation of the charges the cylindrical holes in the lead were enlarged into cavities of a pear shape (and sometimes approaching the spherical form) of various diameters; in some instances the metal was besides partially torn open in a line from the bottom of the charge-hole to the circumference of the lower face of the cylinder; and in the case of some of the gun-cotton charges, the fissure in the metal in this direction was complete, the base of the block being separated from the remainder, in the form of a cone. In the first place the portions of the holes above the charges were simply left open; in the subsequent experiments they were filled up to a level with the upper surface, with dry, fine, loose sand, or with water. The dimensions of the cylinders were increased in successive experiments until, in the case of every one of the explosives used, the mass of metal was sufficiently great to resist actual fracture at the base of the cylinder. Under the condition of these experiments, more or less considerable resistance being opposed to the mechanical dispersion of the plastic explosive substances, their detonation was greatly facilitated, though even then, the holes in the lead blocks being left open to the air, some amount of the blasting gelatine evidently escaped detonation; the widening of the upper part of the charge-hole, in experiments of this nature made with the gelatine, indicated that detonation was transmitted to small portions dispersed in the first instance and in the act of escaping from the block. In all the experiments, whether the holes were left open or filled with sand or water, the effect produced upon the base of the block by the detonation of compressed gun-cotton, was considerably more violent than with the other explosive agents, indicating a sharpness of action which was only shared by the blasting gelatine when used *in a frozen state* in one of these experiments. The dimensions of the cavities produced by the gelatine were, at the largest part, considerably greater than those produced by the dynamite and nitrated gun-cotton (tonite), and slightly greater than those of the gun-cotton charges; but in the latter, the fracture of the base of the cylinder gave rise in most of the experiments to an escape of force, so that in these cases the effects of the detonation could not be well compared by measurements of the cavities. When the gelatine was converted by freezing into a rigid mass its superiority in explosive force even over compressed gun-cotton

[1] Weekly Evening Lecture at the Royal Institution, Friday, March 21, 1879. By Professor Abel, C.B., F.R.S. Revised by the Author. Continued from p. 45.

was well illustrated; the base of the lead block was all but blown out, the cavity produced was considerably the largest, and the suddenness and violence with which motion was imparted to the water tamping caused the top of the block also to be blown off in the form of a cone.

The difficulties attending the application of blasting gelatine, in some directions in which explosive agents are applied, on account of the uncertainty attending the development of its explosive force, even with the use of a comparatively powerful detonator, unless it be very strongly confined, has led to attempts to reduce its non-sensitiveness to detonation by mixing it with materials intended to operate either by virtue of their comparatively great sensitiveness or of their property as solids, of reducing the very yielding character of the substance, or in both ways.

Some of these attempts have been attended with considerable success. Thus the incorporation of about 10 per cent. of the most explosive form of gun-cotton or trinitrocellulose, in a very finely divided state, with the gelatine, renders it so much more sensitive that it can be detonated with certainty in the open air by means of the strongest detonating cap now used for exploding dynamite. This effect appears to be less due to the comparative sensitiveness of gun-cotton to detonation than to the modification effected in the consistency of the material, which, though still plastic, offers decidedly greater resistance to a blow than the original gummy substance. The particles of hollow fibre of the gun-cotton appear also to have the effect of absorbing small quantities of nitro-glycerine which are less perfectly united with the soluble gun-cotton than the remainder, and which, existing as they do in somewhat variable proportions in the gelatine, have occasionally an objectionable tendency to exudation, if the incorporation of the ingredients has been less perfect than usual. The substance, when modified as described, has no longer that great adhesiveness which is exhibited by it in the original state, and which renders it less easy to manipulate.

Lastly, its explosive force appears to be in no way diminished by this modification of its composition; on the contrary, its superiority in this respect to compressed gun-cotton becomes more manifest, as demonstrated by some of the experiments with lead blocks, while its action partakes of that sharpness peculiar to the detonation of the rigid gun-cotton, as indicated by the fissure of that part of the metal situated beneath the charge. Finely divided cotton fibre has a similar effect to trinitrocellulose in modifying the physical character and increasing the sensitiveness to detonation of the blasting gelatine, but its explosive force is, of course, proportionately reduced with its dilution with an inert substance.

Nobel has made the interesting observation that an addition to the blasting gelatine of small proportions of certain substances rich in carbon and hydrogen, which are soluble in nitro-glycerine, such as benzol and nitro-benzol, increases to a remarkable extent the non-sensitiveness to detonation of the original material; and this observation has led to experiments being conducted by engineer officers in Austria, with a view of endeavouring to convert the blasting gelatine into a material which should compete, as regards some special advantages in point of safety, with wet gun-cotton in its application to military and naval purposes, and especially as regards non-liability to detonation or explosion by the impact of rifle bullets. If boxes containing dry compressed gun-cotton are fired into from small arms even at a short range, the gun cotton is generally inflamed, but has never been known to explode. It is scarcely necessary to state that wet gun-cotton, containing even as little as 15 per cent. of water, is never inflamed under these conditions. On the other hand, dynamite is invariably detonated when struck by a bullet on passing through the side of the box, and blasting gelatine, though so much less sensitive than dynamite, behaves in the same way in its ordinary as well as in the frozen condition. The Austrian experiments indicated that the gelatine when intimately mixed with only 1 per cent. of *camphor*, generally, though not invariably, escaped explosion by the impact of a bullet, but that when the proportion of camphor amounted to 4 per cent. the material was neither exploded nor inflamed, though, in the frozen state, it was still liable to occasional explosion. These results were considered indicative of a degree of safety in regard to service exigencies, approaching that of wet compressed gun-cotton. The camphoretted gelatine still labours, however, under the disadvantage of being readily inflammable and of burning fiercely, and consequently of giving rise, like dynamite and dry gun-cotton, to violent explosion, or detonation, if burned in considerable bulk. Moreover, the camphoretted blasting gelatine is so difficult of detonation by the means ordinarily applied that a large initiative charge of a specially violent detonating mixture is prescribed by the Austrian experimenters as being indispensable to its proper detonation.

The action of camphor and of other substances rich in carbon and hydrogen in reducing greatly the sensitiveness to detonation of the preparation of soluble gun-cotton and nitro-glycerine is not to be traced to any physical modification of that material produced by the addition of such substances, and no satisfactory theory can at present be advanced to account for it on chemical grounds.

The camphoretted gelatine, like Nobel's original gelatine itself, may be kept immersed in water for a considerable time without any important change; the surface of the mass thus immersed becomes white and opaque, apparently in consequence of some small absorption of water, but no nitro-glycerine is separated, and on re-exposure to the air the material gradually assumes once more its original aspect. It has consequently been proposed to render the storage of blasting gelatine comparatively safe by keeping it immersed in water till required for use, but the test of time is still needed to establish the unalterableness of the material under this condition.

There can be little question that this interesting nitro-glycerine preparation, either in its most simple form, or modified in various ways, by the addition of other ingredients, promises, by virtue of its great peculiarities as a detonating agent, to present means for importantly extending the application of nitro-glycerine to industrial purposes; and it is not improbable that, through its agency, this most violent of all explosive agents at present producible upon a large scale may also come to acquire special value for important war-purposes.

It has been pointed out that the complete solidification, by freezing, of plastic preparations containing nitro-glycerine, such as dynamite and the blasting gelatine has the effect of facilitating the transmission of detonation throughout the mass under certain conditions of their applications, *i.e.*, when they are either freely exposed to air or not very closely or rigidly confined. But while, under circumstances favourable to the detonation of these substances, when in the frozen state, their full explosive force is thus much more readily applied than when they are in their normal (thawed) condition, the frozen substances are less sensitive to detonation by a blow or an initiative detonation. On the other hand, if subjected to the rapid application of great heat (as for example by the burning of portions of a mass of the explosive substance itself), a detonation is much more readily brought about with the frozen material than if it be in its normal condition. Thus a package containing 50 lb. of cartridges of plastic dynamite, when surrounded by fire, burned away without any indication of explosive action; on submitting 10 lb. of frozen dynamite to the same treatment, that quantity also burned without explosion, though at one time the combustion was so fierce as to indicate an approach to explosive action; but when the experiment was repeated on the same occasion with 15 lb. of frozen dynamite a very violent detonation took place after the material had been burning for a short time.

The following is offered as the most probable explanation of this result. When a mass of dynamite, as in these cartridges, is exposed to sufficient cold to cause the nitro-glycerine to freeze, it does not become uniformly hardened throughout, partly because of slight variations in the proportion of nitro-glycerine in different portions of the mixture composing the cartridge, and partly because unless the exposure to cold be very prolonged the external portions of the cartridges will be frozen harder or more thoroughly than the interior. It may thus arise that portions of only partially frozen or still unfrozen dynamite may be more or less completely inclosed in hard crusts, or strong envelopes, of perfectly frozen and comparatively very cold dynamite. On exposure of such cartridges to a fierce heat very rapidly applied, as would result from the burning of a considerable quantity of the material, some portion of one or other of the cartridges would be likely to be much more readily raised to the igniting or exploding point than the remaining more perfectly frozen part in which it is partly or completely imbedded. If the ignition of this portion be brought about (which it will be with a rapidity proportionate to the intensity of heat to which the cartridge is exposed), the envelope of hard frozen dynamite by which it is still more or less completely surrounded and strongly confined, will operate like the metal envelope of a detonator, in developing the initial pressure essential for the sudden raising of the more readily in-

flammable portion of the dynamite to the temperature necessary for the sudden transformation of the nitro-glycerine into gas, and will thus bring about the detonation of a portion of the cartridge, which will act as the initiative detonator to the remainder of the dynamite. On igniting separately, at one of their extremities, some dynamite cartridges which had been buried in snow for a considerable period, the lecturer has observed that, as the frozen material gradually burned away, very slight but sharp explosions (like the snapping of a small percussion cap on a gun nipple) occurred from time to time, portions of the frozen dynamite being scattered with some violence. It has come to his knowledge that small heaps of hard-frozen cartridges weighing altogether one pound have been detonated by igniting one cartridge which was surrounded by the remainder. These facts appear to substantiate the correctness of the foregoing explanation. They point to the danger of assuming that, because dynamite in the frozen state is less sensitive to the effects of a blow or initiative detonation, than the thawed material, it may therefore be submitted without special care to the action of heat, for the purpose of thawing it. Instances of the detonation, with disastrous results, of even single cartridges of frozen dynamite, through the incautious application of considerable heat (as for example by placing them in an oven, or close to a fire), have been, and are still, of not unfrequent occurrence, even though Mr. Nobel has insisted upon the application of heat through the agency only of warm water, as the sole reliable method of safely thawing dynamite cartridges.

While the sensitiveness to detonation of air-dry gun-cotton remains unaffected by great reduction in temperature of the mass, and while in this respect it presents advantages over nitro-glycerine preparations, wet gun-cotton becomes very decidedly more susceptible to detonation when frozen. Thus the detonation of gun-cotton containing an addition of from 10 to 12 per cent. of water is somewhat uncertain with the employment of 100 grains of strongly confined fulminate, and 200 grains are required for the detonation of the substance when containing 15 to 17 per cent. of water; but the latter in a frozen state can be detonated by means of thirty grains of fulminate, and fifteen grains are just upon the margin of the amount requisite for detonating, with certainty, frozen gun-cotton containing 10 to 12 per cent. of water.

The effects produced and products formed by the explosion of gun-cotton in perfectly closed spaces, both in the loose, and the compressed form, and by its detonation in the dry and the wet state, have been made the subject of study by Capt. Noble and Mr. Abel, the method of research pursued being the same as that followed in their published researches on fired gunpowder; results of considerable interest in regard to the heat of explosion; the pressures developed, and the products of explosion of dry and wet gun-cotton, have been obtained, which are about to be communicated to the Royal Society.

It may briefly be stated that the temperature of explosion of gun-cotton is more than double that of gunpowder (being about 4,400° C.); that the tension of the products of explosion, assuming the material to fill entirely the space in which it is fired, is considerably more than double that of the powder-products under the same conditions; that the products obtained by the explosion of dry gun-cotton are comparatively simple and very uniform under different conditions as regards pressure; that the products of *detonation* of *dry* gun-cotton do not differ materially from those of its explosion in a confined space, but that those furnished by the detonation of *wet* gun-cotton present some interesting points of difference. Messrs. Nobel and Abel are extending their investigations to the nitro-glycerine preparations.

The great advance which has been made within the last twelve years in our knowledge of the conditions which determine the character of the metamorphosis that explosive substances undergo, and which develop or control the violence of their action, finds its parallel in the progress which has been made in the production, perfection, and application of the two most prominent of modern explosive agents, nitro-glycerine and gun-cotton. Discovered at nearly the same time, less than forty years ago, the one speedily attained great prominence, on account of the apparent ease with which it could be prepared and put to practical use; a prominence short-lived, however, because the first, and somewhat rash, attempts to utilise it preceded the acquisition of sound and sufficient knowledge of its nature and properties. Even many years afterwards, when the difficulties attending its employment appeared to have been surmounted, the confidence of its most indefatigable partisans and staunchest friends received a rude shock, from which it needed the support of much faith and some fortitude to recover.

Meanwhile, the other substance, which now shares with it the honours of important victories won over gunpowder, continued to be generally regarded as a dangerous chemical curiosity, even for some time after its present position as one of the most important industrial products and useful explosive agents was being gradually but firmly secured for it, step by step, by the talent and untiring energy of a single individual.

Almost from the day of its discovery, the fortunes of gun-cotton continued to fluctuate, and much adversity marked its career, until at last its properties became well understood, and its position as a most formidable explosive agent, applicable on a large scale, with ease, great simplicity, and with a degree of safety far greater than that as yet possessed by any other substance of this class, has now become thoroughly established. Since the lecturer last discoursed on the properties of gun-cotton, seven years ago, this material has attained a firm footing as one of the most formidable agents of defence and offence. For all military engineering operations, and for employment in submarine mines and torpedoes, compressed gun-cotton, stored and used in the wet condition, has become the accepted explosive agent in Great Britain; within the last five years upwards of 550 tons have been manufactured for this purpose, and are distributed over our chief naval stations at home and abroad. Germany some years since copied our system of manufacture and use of gun-cotton; France has provided itself with a large supply for the same purposes, and Austria, where the acquisition of bitter experience of the uncertainty of gun-cotton in the earlier stages of history, naturally gave rise to a persistent scepticism regarding its present trustworthiness, appears now also about to adopt wet gun-cotton for military and naval uses.

But while the usefulness and great value of compressed gun-cotton in these important directions have been established, its technical application has made but slow progress as compared with that of the simple nitro-glycerine preparation known as dynamite, which, in point of cost of production and convenience for general blasting purposes, can claim superiority over compressed gun-cotton. Already in 1867 a number of dynamite factories, working under Nobel's supervision, existed in different countries; in that year the total quantity manufactured amounted to 11 tons; in another year the produce had risen to 78 tons; in 1872 it had attained to 1,350 tons. Two years afterwards the total production of dynamite was nearly trebled, and in 1878 it amounted to 6,140 tons.

There are as many as fifteen factories in different parts of the world (including a very extensive one in Scotland) working under the supervision of Mr. Nobel, the originator of the nitro-glycerine industry, and some six or seven other establishments exist where dynamite or preparations of very similar character are also manufactured.

How far the rate of production of dynamite will be affected by the further development of the value of Nobel's new preparation, the blasting gelatine, it is difficult to foresee, but there appears great prospect of an important future for this very peculiar and interesting detonating agent.

It is hoped that the subjects dealt with in this discourse afford interesting illustration of the intimate connection of scientific research with important practical achievements.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

DR. CARPENTER, Registrar of the University of London, announced his retirement from that office at the annual meeting of Convocation on Tuesday. A unanimous vote was passed, recognising his long and valuable services in the post which he had so long held.

THE recent retirement of Prof. Balfour from the Chair of Botany at Edinburgh has given rise to two changes in the Scottish professoriate. As his successor, our readers know, the Curators have appointed Dr. Alexander Dickson, the able Professor of Botany in the University of Glasgow. The botanical class has always been popular at Edinburgh, Dr. Balfour's students having recently numbered, we believe, upwards of 350. The class-room of the new professor, also, is so crowded that many of the auditors can hardly find standing-room, large numbers having been unable even to gain admission. Prof. Dickson is

therefore under the necessity of lecturing twice a day. His retirement from Glasgow College has opened the way for a young botanist of great promise, Dr. I. Bayley Balfour, son of the veteran professor at Edinburgh, who has been appointed by the Crown to the vacant chair. Dr. Balfour took the degree of Doctor of Science in Botany some years ago with great distinction at Edinburgh. He was selected by the Council of the Royal Society to accompany the recent Transit of Venus Expedition to Rodriguez for the purpose of making a scientific examination of that island. As the result of his researches, besides the report on the natural history, which he has sent in to the Royal Society, he has produced an excellent paper on the genus *Halophila*. Having had considerable experience in class-work under his father, as well as under Professors Huxley and Sir Wyville Thomson, he enters on his new duties with many advantages. Whether as an original investigator or as a successful teacher, he will, we doubt not, fully sustain the reputation of the Glasgow University.

We are glad to notice that the School Board for London have decided that it would be expedient to include the elements of natural science among the recognised subjects of class examination. The object of this resolution is to transfer what is called elementary science from the category of specific subjects into the category of class subjects. At present there is little inducement for pupils to take science subjects, nor will there be until it be included in the regular course of instruction in elementary schools. We hope the memorial which the Board is to prepare will be treated with the attention it deserves.

SOCIETIES AND ACADEMIES

London

Royal Society, May 8.—"On the Sensitive State of Electrial Discharges through Rarefied Gases." By William Spottiswoode, P.R.S., and S. Fletcher Moulton, late Fellow of Christ's College, Cambridge.

It has frequently been remarked that the luminous column produced by electric discharges in vacuum tubes sometimes displays great sensitiveness on the approach of the finger, or other conductor, to the tube. This is notably the case when with an induction coil a very rapid break is used, or when with any constant source of electricity an air-spark is interposed in the circuit leading to the tube. The striking character of the phenomena, and the opportunity which they showed for affecting the discharge from the outside during its passage, led the authors of this paper to consider that a special examination of this sensitive state would be desirable.

All the circumstances under which sensitiveness is produced appear to agree in requiring, first, that there should be a rapid intermittance in the current leading to the tube; and secondly, that the individual intermittent discharges should be small in quantity and extremely brief, if not instantaneous, in duration. Both these requirements are fulfilled by the methods used in the present investigation, viz., a Holtz machine with a suitable air-spark between the machine and the tube, and a small coil with a rapid break.

If a conductor be made to approach a tube conveying a sensitive discharge, due to an air-spark in the positive branch of the circuit, a series of effects is produced, of which the feeblest and the strongest are the most pronounced. The transition from one to the other is so rapid that the intermediate phases may be easily overlooked. In the first case, the luminous column is repelled by the conductor; in the second it is broken into two parts which stretch out in two tongues towards the point on the tube (P) nearest the conductor, while a negative halo appears between them.

That these effects are due to the inductive action of the conductor, or more particularly to re-distributions of electricity in it, co-periodic with the air-spark, and not to any permanent charge, is shown by the following experiments. A non-conductor, whether charged or not, is without effect. The effect of a conductor increases with its size or capacity, and with its proximity to the tube, until the fullest effect (viz., that given by an earth connexion) is produced. That the effects are not due to electrodynamic, or to magnetic action, is shown by the fact that a coil of wire produces the same result, whether the ends be joined or not. The effects of an iron core and helix with open ends are often comparable with, and sometimes equal to, those when the ends, being connected with a battery, the whole becomes an electro-magnet. The effect upon the interior is, in fact, due to the relief given by the conductor to the electric tension on the outer surface of the tube and the space around it, caused by the individual discharges.

Instead, however, of connecting a point (P) on the tube with a large conductor or with earth, we may connect it with one or other terminal of the tube. And a further study of the subject shows that all the phenomena due to action from without may be produced by means of one or other of these connexions. Connexion with the non-air-spark terminal gives the relief effects described above; connexion with the air-spark terminal gives another set of effects. Of these the feeblest has the appearance of attraction, while the strongest shows an abrupt termination of the positive column in the neighbourhood of the point (P), followed by a negative halo, and then by a recommencement of the positive column in the direction of the negative terminal. Each of these sectional discharges is in fact independent and complete in itself, and they are due to impulses of positive electricity thrown into the tube from the air-spark. At the positive terminal these impulses are thrown directly in; at the points of connexion they are due to induction, *ab extra*. The negative part of what was originally neutral meets the positive column, and satisfies it as it arrives, while the positive leaps forward to meet the negative due from the negative terminal.

The effects above described need not be confined to a single patch or ring of conducting material placed upon the tube; but they may be produced many times over in the same tube by a series of rings arranged at suitable distances. By this means the column may be broken into a series of sections, all terminating with well-defined configurations towards the negative end, and having greater or less length, according to the position of the rings. In the paper itself, arguments are there brought forward showing that these sectional discharges represent striæ not merely in their appearance, but also in their function and structure. But the discussion could hardly be produced within the limits of an abstract.

Returning from the digression about striæ, the authors next give evidence, derived mainly from the revolving mirror, and from the discharges of a partially charged Leyden jar, for the following conclusion: That the passage of the discharge occupies a time sufficiently short in comparison with the interval between the discharges to prevent any interference between successive pulses. Certain experiments are then described which indicate that the discharge is effected, under ordinary circumstances, by the passage through the tube from the air-spark terminal of free electricity, of the same name as the electricity at that terminal. In the case of an induction coil, where the air-spark must be considered as existing at both terminals, there is evidence of a *neutral zone*, where the sensitiveness disappears. The position of this zone may be altered by damping the impulses at either terminal; or it may be abolished by connecting one terminal with earth. The impulses may even be so distributed as to divide electrically a single tube into three sections, the two extremes presenting visible discharges, with a dark section between them.

Looking at all these phenomena from an opposite point of view, we may, by means of the relief effects, determine the terminal from which a discharge proceeds, and the distance to which it reaches without provoking a response from the other. And through these considerations, together with others detailed in the paper, the authors are led to the conclusion that the discharges at the two terminals of a tube are in the main independent, and that they are each determined primarily by the conditions at their own terminal, and only in a secondary degree by those at the opposite terminal.

In illustration of this view, an account is then given of the production of unipolar, positive, or negative discharges in a tube. In such cases, the discharge being insufficient of itself to pass through the tube, returns by the way by which it entered.

This closes a series of experiments, the result of which is that the discharges from the two terminals can be made of equal intensity, or of any required degree of inequality; or the discharge can be made to issue from one terminal only, the other acting only receptively; or it can be made to return into its own terminal, while the other takes no part in the discharge; or, finally, the two terminals can be made to pour out independent discharges of the same name, each of which returns to its own terminal.

Having traced the relation between the two parts of the discharge, and having found means for controlling their range and influence, the authors were led to inquire whether there be any experimental evidence of the state of the tube during the occurrence of the discharge. Some experiments with two pieces of

tinfoil of unequal size placed near the ends of the tube and metallically connected, and others with a strip of tinfoil placed along the tube, all gave effects showing that the discharge cannot be simultaneous throughout the tube. The phenomena appear to require for their interpretation that, in front of the pulse coming from the (positive) air-spark terminal, there is, during the interval between the pulses, a rising negative potential. This is entirely swept out by the pulse as it advances along the tube, after which the process is repeated. The condition of things behind the pulse is more difficult to determine, but an experiment with the telephone gives reason to think that parts of the tube nearer to the non-air-spark end are in a condition to demand relief, before those nearer to the air-spark terminal have ceased to require it. And on this account the discharge may, perhaps, be more nearly represented by a lazy tongs than by a bullet.

How far the results obtained from the sensitive state are applicable to ordinary discharges is a question which cannot yet be definitively answered. But the marked similarities in the phenomena, and the predisposing circumstances of striation or non-striation, as well as in the terminal peculiarities of the two kinds of discharge, point strongly to the conclusions that all vacuum discharges are "disruptive"; and that sensitive differ from non-sensitive discharges mainly in the scale of the discontinuity due to the disruptiveness, causing a difference between the two classes of phenomena analogous to that between impulsive and continuous forces in dynamics.

Mathematical Society, May 8.—Mr. C. W. Merrifield, F.R.S., president, in the chair.—Messrs. A. J. C. Allen and E. Anthony were elected Members.—The following communications were made:—On the complex whose lines join conjugate points of two correlative planes, Dr. Hirst, F.R.S.—Note on a geometrical theorem connected with the function of an imaginary variable, Prof. Cayley, F.R.S.—Some definite integrals, the late Prof. Clifford, F.R.S.—A method of constructing, by pure analysis, functions X, Y, &c., which possess the property that $\int X\,Y d\sigma = 0$, and such that any given function can be expanded in the form $\alpha X + \beta Y + \gamma Z + \ldots$, Mr. E. J. Routh, F.R.S.—The numerical calculation of a class of determinants, and a continued fraction, Mr. J. D. H. Dickson.—On the inscription of the regular heptagon, Rev. Dr. Freeth.

Zoological Society, May 6.—Prof. W. H. Flower, F.R.S., president, in the chair. A letter was read from Mr. E. L. Layard, F.Z.S., relating to the localities of certain species of Fruit-Pigeons (*Ptilopus*) of the South Pacific Islands.—Prof. Flower, F.R.S., exhibited and made remarks on a drawing of a British Cetacean (*Delphinus tursio*), taken from a specimen captured near Holyhead in 1878.—A communication was read from Mr. Gerard Krefft, giving the description of a supposed new form of insectivorous Bat, of which a specimen had been obtained on the Wilson River, Central Queensland.—The Rev. Canon Tristram, C.M.Z.S., read a description of a new species of Wood-pecker, from the Island of Tyzu Sima, near Japan, which he proposed to name after its discoverer, *Dryocopus richardsi*.—A communication was read from Mr. F. Moore, F.Z.S., containing the descriptions of new genera and species of Asiatic Lepidoptera Heterocera. Eleven new genera were characterised and ninety new species described.—Mr. G. French Angas, C.M.Z.S., read the descriptions of ten new species of shells of the genera *Axinæa* and *Pectunculus*.—A communication was read from Mr. W. A. Forbes, F.Z.S., on the anatomy of the African Elephant, based on the facts observed during a dissection of a young female of that species during the last winter. The structures of the thoracic, alimentary, and urino-genital viscera of this species were described, and compared with the previously published accounts of those of both the Indian and African species of Elephant. The most important differences observed were those displayed in the liver and female organs, but on the whole were not of such a nature as to make it advisable, in the author's opinion, to separate *Loxodon* as a genus from *Elephas* proper.—A paper was read by Mr. F. Jeffrey Bell, F.Z.S., on the question of the number of anal plates in the Echinoderms of the genus *Echinocidaris*.

Geological Society, April 30.—Henry Clifton Sorby, F.R.S., president, in the chair.—Alfred Stanley Foord was elected a Fellow of the Society.—The following communications were read:—A contribution to the history of mineral veins, by John Arthur Phillips, F.G.S. In this paper the author described the phenomena of the deposition of minerals from the water and steam of hot springs, as illustrated in the Californian region, referring especially to a great "sulphur bank" in Lake County, to the steamboat springs in the State of Nevada, and to the great Comstock lode. He noticed the formation of deposits of silica, both amorphous and crystalline, inclosing other minerals, especially cinnabar and gold, and in some cases forming true mineral veins. The crystalline silica formed contains liquid-cavities, and exhibits the usual characteristics of ordinary quartz. In the great Comstock lode, which is worked for gold and silver, the mines have now reached a considerable depth, some as much as 2,660 feet. The water in these mines was always at a rather high temperature, but now in the deepest mines it issues at a temperature of 157° Fahr. It is estimated that at least 4,200,000 tons of water are now annually pumped from the workings; and the author discussed the probable source of this heat, which he was inclined to regard as a last trace of volcanic activity.—*Vectisaurus valdensis*, a new Wealden Dinosaur, by J. W. Hulke, F.R.S. The characters presented by the genus *Vectisaurus* were stated to be as follows:—Ilium with a long compressed antacetabular process, having its greatest transverse extent in a vertical plane, and strengthened by a strong ridge produced from the sacral crest. Vertebræ in anterior dorsal region having opisthocœlous centres, their lateral surfaces longitudinally concave, transversely gently convex, meeting below in a blunt keel.—On the Cudgegong diamond-field, N.S.W., by Mr. Norman Taylor.—On the occurrence of the genus *Dithyrocaris* in the lower carboniferous, or calciferous sandstone series of Scotland, and on that of a second species of *Anthrapalæmon* in these beds, by R. Etheridge, Jun., F.G.S.

CAMBRIDGE

Philosophical Society, May 5.—A communication was made to the Society by Prof. T. McK. Hughes, on the relation of the appearances of life upon the earth to the known breaks in the continuity of the older sedimentary rocks. In his introductory remarks the author explained the manner in which he believed the transference of the area of the growth of sediment took place by gradual depression on one side and elevation on the other, and pointed out that there was stratigraphical evidence of the earlier commencement of the accumulation of a continuous series in one area than another, and that often the direction of the movements could be inferred. To the compulsory migration of species consequent upon these movements he attributed the extinction of those that could not adapt themselves to the new circumstances, the appearance of the colonies described by Barrande, and also the gradual introduction of new forms of life throughout the whole of the sedimentary rocks. The principal part of the paper was upon the last question, the author holding that it was only reasoning in a circle to define formations palæontologically and then to speak of the incoming and outgoing of species as nearly coincident with the beginning and end of the formation. He classified the whole sedimentary series on the principle of grouping together all the sediment continuously deposited in any one area, and indicated by corresponding intervals the period during which there was in that area denudation only, the deposition of the denuded material necessarily going on elsewhere. Then, giving an analysis of the palæontology of the older rocks, he showed that the various forms of life came in gradually as compelled to move, and as their travelling powers allowed them, from adjoining areas where local conditions had become unfavourable, pointing out that they did not generally first appear at the beginning or disappear at the close of any series of continuous deposits, but that new forms kept turning up all through, and that after a long interval, whether measured by denudation or deposition, about the same kind and amount of palæontological change had occurred, the chances being that in so long a time geographical changes had taken place in the surrounding district. He showed that thus the palæontological confirmed the stratigraphical evidence with regard to the persistence of continental as well as of oceanic areas, as the sequence of life on the earth required that there could never have been an interruption in the continuity of suitable land and water. He appealed to physicists to tell us whether chiefly to the transference of such great masses of material always to the coast lines of continents, or to secular cosmical action, or to both, we should refer this persistent creeping of earth folds in various directions at different times.

PARIS

Academy of Sciences, April 28.—M. Daubrée in the chair.—The following papers were read:—On the electric light,

by M. Jamin (see last week's NATURE).—On criticism of experiments undertaken to determine the direction of the pressure in oblique arches, by M. de la Gournerie.—On the choice of moduli in hyperelliptic integrals, by M. Borchardt.—The president of the Venus Transit Committee presented fascicle B of "Documents relating to Measurement of Photographic Negatives." This includes a thorough discussion of the measurements at St. Paul's Island.—Report on a note relative to the embankment of the Tiber at Rome, presented by M. Dausse. Instead of trying to obviate inundations by high quay walls, this engineer recommends a partly natural deepening of the bed, securing continuous navigation. He bases his arguments on results of a system adopted on the Po and elsewhere, in which the river is narrowed by submersible dykes (within insubmersible ones), and by its thus increased velocity insures a sufficient draught of water. In flood-time the water-level is lower than formerly, and the expanded river gives rich deposits in the larger bed beyond the submersible dykes.—On the electrical inscription of speech, by M. Boudet de Paris. A very sensitive microphonic transmitter is used, in which the carbons are simply held in contact by a small piece of paper folded in the form of V. The receiving telephone has diaphragm and cover removed, a spring fixed at one end on the wood, and at the other end (to which is added a small piece of soft iron), resting on the magnet; a light bamboo style with whalebone extremity is attached to the spring, and gives instructive traces on decalcomanic paper.—Observation of the periodic comet II., 1867 (Tempel), made by M. Tempel at Florence Observatory.—On a new form of co-ordinates in the problem of two bodies, by M. Gyldén.—On a class of non-uniform functions, by M. Picard.—Theoretical and experimental demonstration of the following definition of temperature: Temperature is represented by the length of calorific oscillation of the molecules of a substance, by M. Pictet. He verifies these two laws: 1. The higher the points of fusion, the shorter are the molecular oscillations. 2. The temperatures of fusion of solids corresponding to equal lengths of oscillation, and the product of the lengths of oscillation by the temperatures of fusion, should be a constant number for all solids.—Siren with electromagnetic regulator, by M. Bourbouze. An improvement on an apparatus described December 18, 1876; with a pinion and double rack he can simultaneously bring near both electromagnets to the copper disk or remove them, obtaining any note in the siren.—On a mode of continuous registration of the direction of the wind, by M. André. This instrument, constructed by M. Redier, is used at Lyons Observatory.—On the present state of Vesuvius, by M. Semmola. The large crater of 1872 is almost wholly filled up; the new cone of eruption has grown so that it is now on a level with the old crater, and will soon be above it. Lavas are sometimes poured out on the north side, and seen from Naples. Fumeroles of lava are very frequent and lively on the interior walls of the old crater; they are all acid. (The products, &c., are described.)—On the laws of dissociation, by MM. Moitessier and Engel. From experiments with hydrate of chloral they find (*inter alia*) that the dissociation of a substance whose two components are volatile takes place even in presence of one of the products of the dissociation, so long as the tension of this product does not exceed that of dissociation of the substance at the temperature operated with.—On the determination of glucose in the blood, by M. Cazeneuve.—Facts bearing on the history of beer yeast and alcoholic fermentation; physical and physiological action of some saline substances on normal yeast, by M. Bechamp. The action of acetate of soda is specially studied.—On the form of muscular contraction of the muscles of the crayfish, by M. Richet. Between the principal muscles, that of the tail and that of the claw, there is as considerable a difference as between smooth and striated muscles in vertebrates.—The cochineals of the young elm, a new genus, *Ritsemia pupifera*, by M. Lichtenstein.—Why one sometimes finds plants of limestone associated with those of silica, by M. Contejean.

May 5.—M. Daubrée in the chair.—The following papers were read:—On the heat of formation of cyanogen, by M. Berthelot. Cyanogen (like acetylene and bioxide of nitrogen) is a substance formed with absorption of heat. The mean number, 132·3 cal., was obtained for its heat of combustion (the equivalent (C_2N = 26 grammes); this number is somewhat less than Dulong's.—On some derivatives of durol (α-tetramethylbenzine), by MM. Friedel, Crafts, and Ador.—Experiments for determining the direction of the pressure in a slanting arch, by M. de la Gournerie.—On the transformations of the second order of hyperelliptic functions, which, applied twice successively produce duplication, by M. Borchardt.—On the crystals extracted from cast iron by ether or petroleum, by Prof. Lawrence Smith. The cast iron is treated in a finely divided state. It yields a soluble matter consisting chiefly of sulphur, and crystallising in fine needles, like the matter which the author has separated from meteoritic graphite. M. Berthelot stated he had got like crystals by treating artificial or natural sulphides with ether or alcohol, and he attributed the matter to chemical action of the sulphur on the hydrocarbonised solvent. The results inspire reserve in conclusions as to pre-existence, in meteorites, of those crystallisable hydrocarbonised matters which are capable of extraction by organic solvents.—M. Daubrée presented a memoir by M. Abich, on the production and geotechnic conditions of the naphtha region near the Caspian.—Mr. MacCormick was elected correspondent for the section of Rural Economy, in room of the late M. Chevandier de Valdrôme.—Reflex effects produced by excitation of the sensitive fibres of the pneumogastric and the superior laryngeal on the heart and vessels, by M. François-Franck. The effects are moderation of the heart's action conjointly with constriction of the vessels.—Effects of sulphide of carbon on the radicular system of the vine, by M. Boitean. He points out certain evils connected with this mode of treatment. The sulphide destroys organic substances which are in its most concentrated atmosphere. Injections should be made 30 or 35 ctm. from the stem, and combined so that there should be two (of 10 grammes) per square metre.—Geometrical determination of umbilici of the surface of the wave, by M. Mannheim.—On the equivalence of algebraic forms, by M. Jordan.—On the calculation of perturbations, by M. De Gasparis.—On a theorem of dynamics, by M. Siacci.—On the thermal formation of siliciated hydrogen, by M. Ogier. He tried to determine the heat of combustion by means of free oxygen; whence he finds the union of $Si + H_4$ to be accompanied by a liberation of heat = + 24·8 cal., which is near the heat of formation of marsh gas (+ 22 cal.).—On the limit of separation of alcohol and water by distillation, by M. Le Bel. Ninety-seven per cent. was attained.—On a new isomer of angelic acid, by M. Duvillier.—Transformation of camphic acid into camphor, by M. De Montgolfier.—On the contractility of blood-capillaries, by M. Rouget. In all vertebrates a contractile coat of the same type, modified only in the number of its elements, envelopes the whole system of vascular blood-canals, including the heart and the capillaries. Contractility (modified only according to region) is an essential property of all the system.—On the action of salts of strychnine on gasteropod molluscs, by M. Heckel. These animals show a remarkable immunity as regards salts of strychnine. As in vertebrates, the degree of injuriousness of the poison is in inverse ratio of the animal's weight. The toxical phenomena are of the same order as in higher animals, *i.e.*, strychnine is a poison of the nervous system (tetanising).—On the *Haptophrya gigantea*, a new opaline of the intestine of anouran Batrachians in Algeria, by M. Maupas.—Artificial reproduction of native carburetted iron of Greenland, by M. Meunier.

CONTENTS

THURSDAY, MAY 22, 1879

MILNE'S CRYSTALLOGRAPHY

Notes on Crystallography and Crystallophysics. By John Milne, F.G.S. (London: Trübner and Co., 1879.)

THAT two little treatises should have appeared, written at so near a date the one to the other as Mr. Gurney's and Mr. Milne's introductory tracts on crystallography, shows that there is at least some want at last beginning to be felt for the means of studying that important but somewhat neglected science.

And it is suggestive of some singular reflections that one of these little treatises should come from Japan written by one of that teaching body at Yedo, of which Prof. Perry is a distinguished member.

Is there a demand springing up among the subjects of the Mikado for branches of knowledge which have hardly obtained a footing in institutions in which scientific training is given in Great Britain? Or is it that the Japanese have enticed to their colleges Englishmen who are so far ahead of their colleagues at home, that they are less trammelled by routine, and endeavour in the instruction they give to the youth of Japan to work out a more complete and comprehensive curriculum for the student of chemical science and physics than is recognised at home? Whatever be the cause, we have, in Mr. Milne's little treatise as we had before in Mr. Gurney's, an attempt to supply an educational want. We must award to Mr. Milne all the credit which is his due for the intention this attempt involves, and for his courage in undertaking it, with what was apparently a small and inadequate equipment either in previous study or in the literary material necessary for making his treatise thorough and worthy of the purpose that suggested it. The book is concise and its form fairly well planned; and if our praise cannot be extended to the execution of that plan the circumstances under which the little volume has been produced have to be considered in extenuation of the dispraise. But in criticising it, it is essential to consider its seventy pages solely on their merits. Like Mr. Gurney, Mr. Milne follows Prof. Miller's system of crystallographic notation, and endeavours to make clear the simplicity and elegance of that system. His first line, however, in explanation of the system, the sixth line of his Introduction, is, to say the least, infelicitous. "In this (Miller's) system," he says, "the symbols of a face consist of three whole numbers, each of which invariably refer to the same axes;" a sentence in which are compendiously represented the faults of the book, faults due partly to inaccuracy of mathematical conception, and partly to a mode of employing the English language, for which perhaps some excuse is to be found in a long residence in Yedo, but which surely one of the three home-editors, Mr. T. Davies, Mr. H. Woodward, and Prof. Morris, might have taken the liberty of correcting.

What Mr. Milne intended to convey in the above ungrammatical sentence was, of course, that the symbol for a plane is constituted by three whole numbers termed indices, which may include one or two zeros; the particular axis to which an index has reference being given by the position of the index in the symbol. If Mr. Milne would, for instance, consider the application of his statement to the symbols for the faces y, y', &c., of the crystal of cuprite, which he discusses on p. 27, and where by the by he makes the blunder in his result of putting (015) for (051), he would find that his statement amounts to the assertion that these two last symbols are identical, an assertion that would reduce the system of Miller to all the ineptitude of that of Naumann.

In deducing on p. 16 the symbol of a zone from the symbols of the planes belonging to it the author proceeds on the tacit assumption that he has rectangular axes to deal with, thus leaving unexplained the case of crystals belonging to systems referred to oblique axes; and these form a large majority of the known crystals.

In his mode of treating the problem by algebraic geometry in the last paragraphs on p. 17 he is certainly not to be congratulated.

It is from this p. 17 that one begins to find the hopelessness of this little book fulfilling, in its present crude form, the purpose its author proposes for it; that, namely, of making the simple system of F. Neumann and Miller intelligible either to the student slenderly equipped with mathematical knowledge, or to the votary, too often the partizan of the system of K. Naumann.

For it is evident that Mr. Milne has been unfortunate in his English editors. Mr. T. Davies, a gentleman universally esteemed for his personal character as well as for a very complete familiarity with minerals and rocks, obtained by the daily handling and scrutiny of them during twenty years of service in the British Museum, undertook, it seems, to pass through the press the little book of which copies lithographed by a Japanese native had been sent home to him and to others by Mr. Milne. If Mr. T. Davies had enlisted the aid of some one who possessed a rudimentary knowledge of algebra and plane trigonometry he might have saved Mr. Milne's little book from being useless. Then probably $\infty - 01$; $\infty - 10$; $11 - \infty$ would have been written $0 \times 0 - 0 \times 1$, &c., and would have been intelligible, and such a misprint as that on p. 21, "$\therefore$ (112) being (*sic*) the indices of the plane at $\perp s$ to [111] and [110]," might have been avoided. Of course a plane $\perp^r$ to [111] and [110] is $(\bar{1}10)$ or $(1\bar{1}0)$ and not (112); but Mr. Milne meant to write the two zones as $[11\bar{1}]$ and $[\bar{1}10]$. Misprints of this serious kind are very numerous; other instances are (loh) for $(lo\bar{h})$, (orq) for $(or\bar{q})$, or $(p - s)$ for $o, r(p - s)$ on p. 22; Wvw for UVW on p. 24; [312] twice for $[\bar{3}12]$ on p. 26; the frequent omission of brackets where they are necessary: for instance, $a^2kr - lq$ instead of $a^2(kr - l\bar{q})$ on p. 17; and these are the sort of errors which puzzle a student who is not a fair mathematician, precisely the student for whom the book is meant, since any one possessed of a little mathematical knowledge would naturally prefer to have recourse to Miller's Tract on Crystallography, a book of the existence of which Mr. Milne seems to be unaware, to judge from a note on p. 34. In a treatise on a science which presents to the student novel forms of notation the want of even the most elementary acquaintance with algebra that has allowed the introduction into the type, of

a comma to represent the sign of multiplication in almost every equation, invests the expressions with a hopeless obscurity; what for instance would a young student fresh from a little algebra make of the expression (p. 30), cos PC = cos PA, cos CA + sin PA, sin CA, cos PAC whence PC? Mr. Milne's editors and not Mr. Milne are of course to blame for this, though most of the other mistakes alluded to are his own.

In a chapter on the projection of poles by the stereographic method Mr. Milne gives a proposition for finding a pole [he means the projection of a pole] at given angular distances from two poles lying on the circle of projection, which is only a special and simple case of the more general problem. The description of the process is entirely unintelligible. If, however, the meaning be puzzled out from the figure it would seem that Mr. Milne is proposing a construction simple and ingenious, although to obtain it he has to combine the orthographic and stereographic projections. His editors might have saved him from using the expression "two half-hemispheres" on p. 38, if not also from the statement that the monosymmetric or monoclinic system can present eight faces for a single form. The chapter on crystallophysics is very unsatisfactory; after one's expectations of somewhat transcendental physics have been raised by being told that for the correlation of the phenomena produced by crystals with crystal-structure, "the most valuable hypothesis would probably be that of molecular vortices," one is certainly surprised to be told that in the orthorhombic, monoclinic, and triclinic systems "there are two optic axes or directions of double refraction"—or again, that "sections in triclinic crystals cut perpendicularly to the optic axes when viewed in a polariscope show a series of rings round each axis. Between the axes these are drawn together and may meet to form a lemniscate." One is inclined to ask whether Mr. Milne has a distinct idea as to what a lemniscate curve is, and how he cuts the section presenting these phenomena?

In speaking of heat conductivity again, the author places the rhombohedral and orthorhombic systems together in one category, and the tetragonal system in another. The errors, often arising in carelessness but sometimes in ignorance, to which these criticisms apply, have been selected merely at random. It has been necessary, however, to make these criticisms in the interest of the student, who might be repelled from a subject when he finds what should be a simple statement apparently untrue or unintelligible, whether on account of misprints or of obscurity in the language, in the thought, or in the author's method of demonstration. But having performed this duty to the student of a beautiful but much neglected science it would be ungenerous to a teacher in far Japan, not to point out that it is still within his power by recasting his little volume to fill a decided gap in our elementary scientific literature. He has the courage and the ability, he needs only a little more familiarity with the subject, a good deal more caution, and perhaps somewhat more of modesty, to enable him to fulfil the not very ambitious purpose he laid down for himself when he sent his little work to be published in England.

N. S. M.

MATHEMATICAL PROBLEMS

I. *Mathematical Problems on the First and Second Divisions of the Schedule of Subjects for the Cambridge Mathematical Tripos Examination.* Devised and arranged by Joseph Wolstenholme, M.A. Second Edition, greatly enlarged. (London: Macmillan and Co., 1878.)

II. *Solutions of the Cambridge Senate-House Problems and Riders for the Year* 1875. Edited by A. G. Greenhill, M.A. (Same Publishers, 1876.)

III. *The Same for the Year* 1878. Edited by J. W. L. Glaisher, F.R.S. (Same Publishers, 1879.)

IV. *Graduated Exercises in Plane Trigonometry.* Compiled and arranged by J. Wilson, M.A., and J. R. Wilson, B.A. (Same Publishers, 1879.)

V. *Geometrical Deductions, Riders, and Exercises, based upon Euclid, Books I.—IV.* (Stewart's Mathematical Series, 1878.)

A COMMON purpose pervades these five works, viz., that of affording practice and aid in the solution of mathematical problems. Prof. Wolstenholme, with a marvellous versatility which has long placed him in the foremost rank of "ten-minute conundrum" makers, sends forth a volume (I.) which now contains 2,815 problems in place of the 1,628 which he published in 1867. Further, his book has increased in all the directions in which it is possible for a book to grow, and the number of valuable hints scattered throughout the volume has been greatly enlarged. Dipping into the book here and there we are fain to cry out "Prodi-gi-ous!" with worthy Dominie Sampson, and to think this problem-compelling Briareus ever

> "Agitates his anxious breast,
> In solving problems mathematic."

We have long used the earlier work with profit to ourselves, and, we believe, to the advantage of our pupils preparing for Cambridge scholarship examinations; this new edition is an improvement upon the old, and in its line seems now perfect. What we would much like to have is Prof. Wolstenholme's solutions of his questions, but we fear the public, needed for the purchase of such a work, is not yet in existence. Doubtless there are many errors in the text, but these can only be found out by a free and long-extended use; however, we have noted in question 443, for the second $\cos^3\theta$ read $\sin^3\theta$; question 925, for a ? $2a$; p. 192, lines 2, 5, put − before Δ.

In the volumes II., III., we have a welcome revival of a fashion which has of late years died out; it never prevailed to any great extent, but its occurrence was generally traceable to the influence of some one or two enthusiasts, who, for the benefit of junior students, were willing to put upon record neat solutions of elegant problems, not counting the cost of publication. Such collections as these are especially valuable, and the volumes before us seem quite equal to their predecessors in the same field. A novelty in III. is the publication of additional remarks on some of the questions. For instance, a concise general statement of the method of least squares is given on pp. 162-169; on p. 8 is a note on circulating decimals, and similar notes occur elsewhere. In this work (III.) we have detected several small errors, p. 13 line 14 insert − before $\frac{3}{16}a^2$; p. 14

there are three errors; p. 147, line 7, dele "is *r*," there are two other errors on this page; p. 187 we have a vague reference to Boole's Differential Equations, and a misprint lower down; there are other minor errors easily detected, but when correcting pp. 114 to 116, somebody must have had his eyes shut at times or he would not have passed such a number of clerical errors.

In IV. we have a fresh work, well adapted for the higher forms in schools, though the examples are in some cases difficult. There are good notes, and the whole book may be recommended to students reading for scholarship or for college terminal examinations. We could put our finger upon many a mistake easily detected by an advanced student, so that we should advise junior pupils not to spend too long a time upon the questions if they do not succeed in getting the same answer as is given in the text. In making this statement we are bound to say that the number of mistakes seems to be no greater than is almost inevitable in a first edition.

The manual V. contains "more than 160 deductions which have been set at public examinations, worked out in full as examples, together with a collection of specimen examination papers, which have been set at the examinations, Cambridge Mathematical Tripos, London University Matriculation, &c." This fuller title gives a good idea of the scope of the work: it aims at doing for junior students what is done for higher students by McDowell's exercises on Euclid and in Modern Geometry. We have only been able to look into the book casually; we have found the parts so examined correct and put in such a way that a lad acquainted with the text of Euclid ought to have no difficulty in following the proofs here given. The student has to draw his own figures. The printing is good and so done as to assist the reader in his work. From the initials attached to the preface we should infer that the compiler is Mr. A. T. Fisher, whose "Book of Algebra" in the same series we commended, at the time of its publication, in these columns.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Spectrum of Brorsen's Comet

I HAVE to thank Dr. Marshall Watts for having called attention to a point of some interest with regard to the spectra of comets, viz., which of the carbon spectra agrees with the cometary spectrum? In the case of Brorsen's comet the most important question was, whether the spectrum differed *largely* from that of other comets, as found by Dr. Huggins in 1868, and not having much leisure at the time of writing to examine the question of the different spectra of carbon, I overlooked the circumstance that the comparison spectrum used by Prof. Young was the first or flame spectrum of carbon. The difference, however, in the positions of the bands in the two spectra of carbon is a quantity which it is not very easy to answer for in the case of a faint cometary spectrum, and it is but a small fraction (less than one-fourth) of the discordance between Dr. Huggins's measures in 1868 and those made at the present return of the comet.

In the comparisons made at Greenwich the induction-spark (without Leyden jars) was taken in a vacuum-tube containing alcohol vapour at a pressure of 1·2 mm., and the green comet-band was compared with this spectrum exactly in the manner described by Dr. Watts, though practical difficulties of manipulation prevented our making comparisons with the flame spectrum, as I wished. In fact the awkward position of the spectroscope in observing the comet below the pole made the observations extremely difficult, and caused great loss of time, so that the results are not so numerous as they would otherwise have been. On April 17 I used a micrometer eye-piece, with a movable bar, the breadth of which corresponded to 30 tenth-metres, whilst the slit was of such a width that the line with which the band in the alcohol-spectrum commences was 45 tenth-metres broad. The bar was brought up from the blue end so as just not to hide the less refrangible edge of the comet-band; the spectrum from the alcohol vacuum-tube was then flashed in, and the less refrangible edge of the carbon-band was found to be just visible beyond the bar. Several comparisons were made in this way, and I estimated that the uncertainty in the determination of the coincidence between the less refrangible edges of the comet and carbon-bands was but a small fraction of the breadth of the bar (30 tenth-metres). I did not obtain any micrometer readings. On April 19 and 28 Mr. Maunder, from readings with a bright-line micrometer, found for the position of the bright edge of the comet-band in the green, compared with the centre of the line at the edge of the alcohol-band (wave-length, 5198·3):—

	Comet-band. Tenth-metres.	Wave-length inferred.	Width of Slit.
April 19	... 0·5 to blue ...	5190 ...	0·009 in. = 16 tenth-metres.
28	... 4·5 to red ...	5191 ...	0·013 ,, = 24 ,,

In computing the wave-length of the bright edge of the comet-band, half the breadth of the alcohol-line (= width of slit) has been applied. In a similar manner the wave-length of the bright edge of the comet-band in the yellow was found to be 2·4 tenth-metres to the red of the edge of the alcohol-band at 5610·5, or at 5580, allowing for the width of the slit, which was 0·033 in. or 65 tenth-metres. The position of the blue band was estimated to be *approximately* coincident with the blue band of alcohol at 4834, but this determination is very rough indeed. The dispersion used was that of one "half-prism," viz., 20° from A to H, equivalent to four flint prisms of 60° with a magnifying power of twelve. In my former letter I, by mistake, gave the dispersion as equivalent to two prisms only, instead of four. The high dispersion used is of course an important element in estimating the accuracy of the determination, and on comparing afterwards the flame and vacuum-tube spectra of carbon with the width of slit and other conditions of observation the same as on April 17 and 19, I found the two bands so widely separated that it appeared impossible to mistake one for the other in estimating a coincidence. I may add that the spectrum of Coggia's comet also was found to be identical with the second spectrum of carbon. With regard to Dr. Huggins's observations of Comet II. 1868, and Coggia's comet, Dr. Watts does not give his reasons for the assertion that the comparison spectrum was the first spectrum of carbon. According to the diagram given by Dr. Huggins, the spectrum in olefiant gas is distinctly different from that in olive oil, which I presume is the first spectrum, and the comet-spectrum agrees with the former. As far as I can judge, this is the spectrum which we have obtained in vacuum-tubes, whether they contain alcohol, carbon-oxide, carbon-dioxide, or olefiant gas. I do not wish to enter on the question as to whether the differences in the carbon-spectra result from differences of chemical composition or of molecular condition depending on temperature, though I may remark that the same vacuum-tube gives quite a different spectrum when Leyden jars are introduced into the circuit.

W. H. M. CHRISTIE

Royal Observatory, Greenwich, May 17

End-on Tubes, brought to Bear upon the Carbon and Carbo-Hydrogen Question

IN NATURE, vol. xx. p. 28, there is an important paper by Dr. Marshall Watts, touching certain recent observations of carbon spectra so-called, which seems to offer an excellent opportunity for clearing up certain long-disputed points in spectroscopy, and to the satisfaction, I hope, of every one.

Firstly, the Doctor alludes to the recent happy case of Prof. Young, of Princeton, U.S., having last month compared the green band of Brorsen's comet with the green band of a Bunsen gas burner, and found them identical in spectrum place, thereby

bringing the said Brorsen's comet into line with most other comets, as to possessing both that band and material.

Secondly, Dr. Watts alludes to Mr. Christie, of the Royal Observatory, Greenwich, having also recently observed the spectrum of the same comet, and stated that he had thereby found the *same* result as Prof. Young. But the Doctor implies there must be some mistake therein, because—what Mr. Christie compared the sharp edge of the comet's green band, with, and found it coincident, was not the Bunsen gas burner's green band, but that of an alcohol vacuum tube illumined by electric spark; and this latter green band, he says, is in an absolutely different spectrum-place to that occupied by the coal-gas burner's green band.

The first answer here, is both pleasant and simple. I know perfectly well what it is the Doctor alludes to, as being visible in the alcohol vacuum tube, but would beg to remind an accomplished laboratory worker that it is so close in spectral place to the coal-gas flame's green band, that in any spectroscope of very small dispersion, and when the subject is seen only faintly and at intervals in a difficult astronomical observation, such minute difference of place might well be disregarded in comparison with the enormous difference or anomaly of an older, almost historic, record, whose large discrepance, eight times larger than the other difference, was really the thing which both Mr. Christie and Prof. Young had before them, either to prove or disprove. And as they have now each of them independently assured us, by special observations at the end of a telescope in the cold night air, that the enormous anomaly suspected of old no longer exists—they both deserve our best thanks.

But next comes, for those who work in-doors with brighter lights and more powerful spectroscopes, the second part of the answer, with a proof that Mr. Christie, after all, may not have used a differently placed reference to Prof. Young's, even in the least degree, because, *besides* what Dr. Marshall Watts says very truly, there is in the spectrum of an alcohol vacuum tube electrically illumined, there is *also* a something else which he either has not seen, or has not yet recognised as such, but which is the very identical green band of the coal-gas flame in open air.

The special green band which the Doctor *has* seen and recognised in an alcohol vacuum tube is to be seen equally in vacuum tubes of all gases containing carbon in any combination, and is therefore abundantly visible in tubes of carbon monoxide, carbon dioxide, and cyanogen. This, too, is the spectrum which he calls the "Carbon spectrum No. 2," but which I call simply the spectrum of carbon; a spectrum which no one has yet found in any common candle flame, coal-gas flame, or comet in the sky; and it requires apparently the ecstatic heating of the electric spark for its smallest development.

But the other green band, which I shall presently prove is also in an alcohol vacuum tube, though the Doctor may not have recognised it there, he has seen abundantly elsewhere, for it is found in the blue base of every candle, lamp, or coal-gas flame, and he has given the spectrum place of the beginning of it with exceeding accuracy. In fact, the only unhappy thing is, that he will look upon it as pure carbon, calling it the "Carbon spectrum No. 1," when it is so evidently the compound "carbo-hydrogen;" for with my new end-on tubes, while I do *not* see *this* green band in vacua of either carbo-oxygen or carbo-nitrogen (unless ultra-faintly as a trace of impurity), I do see it, and most brilliantly, in tubes of such rich carbo-hydrogens as alcohol and olefiant gas.

Now it is not a little singular as a coincidence merely, that I was actually engaged only yesterday, after an interval of several years, in pointing out to my friend Prof. Swan, of St. Andrews, the existence of "his" carbo-hydrogen blow-pipe flame's lines of its green band, projected upon, and differently placed from, the true elemental carbon green band ot an alcohol vacuum tube, electrically illumined; and we proceeded thus to test the identity of what I called "his" flame lines, by a close proof of place, which is everything in spectroscopy.

A coal-gas and air blow-pipe flame, end-on, was set up before the spectroscope on one side of the table, and on the other side an alcohol vacuum tube, illuminated by 1-inch sparks from a small coil, and viewed also end-on. The spectroscope could be rotated easily in azimuth by endless screw motion, so as to look with its gathering telescope first into the tube, then into the flame, and then again into the tube. The prism train had the large dispersion of 33° between A and H, the telescope a magnifying power of 10, and its pointer was one of Mr. Hilger's latest and most refined steel wedges of almost infinite sharpness.

The slit was made exceedingly narrow, the definition in the centre of the field was super-excellent, and then Prof. Swan micrometrically bisected a certain thin but exceedingly bright line, which looked like an anomaly on the surface, and far within the least refracted edge of the elemental carbon green band of the alcohol tube, and clamped the pointer in that exact spectrum place.

I then rotated the whole instrument round to the blow-pipe flame, and asked him "What is the pointer on now?"

"On the first and brightest line of the blow-pipe flame's green band," he answered, "Alexander Herschel's green giant of carbo-hydrogen, and it is admirably bisected too."

We next rotated back to the alcohol tube, and found the pointer still accurately bisecting that bright line present there, which was a total anomaly in a pure carbon spectrum, though perfectly agreeable to what Prof. Swan wrote of the compound carbo-hydrogen's flame spectrum, twenty-three years ago. Most opportunely present also in that tube, for it enabled Mr. Christie to compare Brorsen's comet with the same identical reference as that used by Prof. Young, though employing an alcohol spark spectrum, and not a gas-burner.

The second line of the blow-pipe flame's green band, though much fainter, is also distinctly seen in the end-on view of the alcohol tube's spectrum, and answers perfectly to a similar test for place as the first line. Wherefore, I would beg to ask, how can I hold any other view than that carbon, as a pure chemical element, and the most refractory that is known, has no spectrum short of electric spark temperature; and what it then shows is, to exact measurement with large dispersion, a perfectly different spectrum to that of the compound gas, carbo-hydrogen; which compound gas, while still existing to some extent in the electric spark tubes, begins its spectral manifestations in the very moderate temperature of merely a farthing tallow candle: a matter to be duly considered in studying the physical condition of comets, which do not show any spectrum (or, for small and "uncondensed" sparks, we may say *the* spectrum) of pure elemental carbon. PIAZZI SMYTH

Edinburgh, May 9

The Victoria University

IN the article on the Victoria University in the last number of NATURE, I observe some inaccurate statements regarding the Queen's University in Ireland.

In the first place there are not *four* colleges, but *three*. Next there are no *degree* examinations in any college, but all are conducted in Dublin by the examiners of the university, who, for the most part, are also professors in the colleges; but there are some examiners who are not professors, and also some professors who are not examiners. A. J. C. ALLEN

Peterhouse, Cambridge

Maps of Old Geological Coast-lines, &c., &c.

I NOTICE in Woodward's "Manual of the Mollusca," when speaking of the "Boundaries of Natural History Provinces," p. 352, the following:—

"The seas are divided by continents and influenced by the physical character of coast-lines, by climates, and currents."

May not the occurrence of different species in different parts of contemporaneous strata help to determine the positions of land and water, &c., in past geological ages? W. W.

Cambridge

[In reply to "W. W.'s" interrogatory, "May not the occurrence of different species in different parts of contemporaneous strata help to determine the positions of land and water, &c., in past geological ages?" we would say, Yes, most certainly; and it is not only by recording the occurrence of *different species*, probably peculiar to different zones of depth, that geologists have long tried to mark out old sea-beds, but more especially by tracing carefully *the occurrence* of the *same species* along extended lines of formations, they have attempted to map out old geological coast-lines. Much has been done in this direction by Godwin-Austen, Forbes, Quenstedt, Oppel, Waagen, Hebert, Oswald Heer, and many others; but much more remains to be accomplished, and "W. W." cannot do better than take up some such line of inquiry for his summer vacations. How much good field-work might be done in three months' holidays in, say, three successive years, with a knapsack on one's back and a hammer in one's hand, let the admirable papers by Dr. Chas. Barrois of Lille tell!—H. W.]

Note on the Iodobromite of A. v. Lasaulx

In the *Jahresberichte für Mineralogie* for 1878 A. v. Lasaulx has described a new silver haloid mineral, having the composition Ag_2Br_2, Ag_2Cl_2, AgI, or $Ag_5Cl_2Br_2I$, which he cites as the first instance of the three haloids occurring crystallised together in nature. Several chloro-bromides of silver have been found in Chili in the silver mines of Chañarcillo, and, according to Dana, an iodobromide has also been detected. The present mineral, which should be called *chlorobromiodide*, was found associated with beaudantite in a mine in the district of Ems, Nassau, in the form of small yellow or olive green octohedrons never exceeding 3 mm. in size. The crystals are very malleable, and can be pressed flat with the blade of a knife, and they possess a good deal of lustre. On analysis they were found to contain :—

Silver	59·96
Iodine	15·05
Bromine	17·30
Chlorine	7·09
	99·40

In 1876 I prepared some of this substance artificially by fusing together the chloride, iodide, and bromide in the proportions of AgI 26·1692, AgBr 41·8708, AgCl 31·9600, which gives an ultimate composition of :—

Silver	60·1336
Iodine	14·1435
Bromine	17·8176
Chlorine	7·9053
	100·0000

The substance was prepared with other chlorobromiodides of silver in order to see the extent to which iodide of silver (which contracts considerably when heated from 142° to 145·5° C.) modifies the coefficient of expansion of the chloride and bromide, which do not present similar anomalies. The results obtained are given in the *Proc.* of the Royal Society, vol. xxv. p. 294, 1877, "On the Effects of Heat on some Chlorobromiodides of Silver," and they are of additional interest now that the substance has been found in nature.

The compound artificially prepared is a brittle yellowish-brown solid, giving a bright primrose-yellow powder, which turns green on exposure to light. (It is noticeable that some of the crystals found by Lasaulx were yellow, others green.) It is a crystalline solid which emits loud harsh noises while cooling from the molten condition. The fusing point is 330° C. The sp. gr. 6·152 when cooled quickly, but when fused and allowed to cool slowly in hot paraffine, the sp. gr. fell to 6·066. A. v. Lasaulx makes the sp. gr. of the mineral as low as 5·713. The artificially prepared compound was found to possess a coefficient of cubical expansion for 1° C. = 0·00012216 between 0° C. and 125·5. Between 125·5 and 131·5 it underwent slight contraction, while between 131·5 and the fusing point the coefficient was 0·0001 5882. It possesses two points of similar density, the one at 131·5° C., the other at or about 123° C. The volumes calculated from the coefficients, taking volume at 0° C. as unity, were found to be :—

Volume at	0° C.	= 1·000000
„	125·5°	= 1·015331
„	131·5°	= 1·015037
„	330°	= 1·046666 (solid)
„	330°	= 1·104050 (liquid)
„	750°	= 1·177979

It is presumable that the other artificially-prepared chlorobromiodides described in the paper cited above will also be found in silver mines.

G. F. Rodwell

Inherited Memory

Having had my attention called, of late, to the subject of the migration of birds, I have of course been interested in the discussion between Dr. Weismann and Prof. Newton, and I cannot help fancying that I have hit on the "missing link" which connects the theory of the former with the facts of the latter.

Are there not scientific men (and is not Dr. Carpenter one of them) who consider that when we say an event has made "such an impression on us that we shall never forget it"—we are not merely using a metaphor, but stating a fact? Now if something analogous to "making an impression" on the brain really takes place whenever we commit anything to memory—is it not possible that if the impression be deeply fixed, the impressed brain may be transmitted by the parent to the offspring, who thus "inherits" its ancestor's memory?

When we remember that birds take the same journey year after year, generation after generation, century after century, nay, even for ages after ages, I think we shall feel that there are more marvellous things in nature than what I am asking you to consider, namely, the possibility that the young bird at last inherits a knowledge of the way, and is capable of performing the journey alone.

If "inherited memory" be accepted as a fact, what a flood of light is thrown on many puzzles which have hitherto been classed as "instincts"; such as the building of birds' nests; the pointing of pointer puppies, the knowledge possessed by young animals of right and wrong food, and of friends and enemies; I am not sure that it will not even throw light on some mysteries in human nature. When I was a child I had a dread of wolves (a very common thing with children), and I find the dread reproduced in one of my own children. Yet wolves have been so long extinct in England that we should probably have to go back many generations before we met with the nurses who quieted crying children by threatening to give them to the wolves. May not this be a case of "inherited memory?"

A. B.

Intellect in Brutes

Some years ago the late Hon. Marmaduke Maxwell, of Terregles, took me to his stable to show me a cat which was at the time bringing up a family of young rats. The cat some weeks previously had a litter of five kittens, three were taken away and destroyed shortly after their birth; next day it was found that the cat had replaced her lost kittens by *three* young rats which she nursed with the two remaining kittens; a few days afterwards the two kittens were taken away, and the cat very shortly replaced them by *two* more young rats, and at the time I saw them, the young rats—which were confined in an empty stall—were running about quite briskly, and about one-third grown. The cat happened to be out when we went into the stable, but came in before we left; she immediately jumped over the board into the stall, and lay down; her strange foster-family at once ran under her and commenced sucking. What renders the circumstance more extraordinary is, that the cat was kept in the stable as a particularly good ratter.

Cargen, Dumfries, May 9 P. Dudgeon

Phosphorescence

In regard to the effect of heat on phosphorescence, your correspondent in last week's number will find that almost similar phenomena have been observed by Dr. Draper, who treats of the whole subject very fully and satisfactorily in his "Scientific Memoirs."

G. S. Thomson

Clifton, May 18

AN INDUCTION-CURRENTS BALANCE[1]

Immediately upon the announcement of Arago's discovery of the influence of rotating plates of metal upon a magnetic needle (1824), and Faraday's important discovery of voltaic and magneto-induction (1831), it became evident that the induced currents, circulating in a metallic mass, might be so acted upon either by voltaic or induced currents as to bring some new light to bear on the molecular construction of metallic bodies.

The question was particularly studied by Babbage, Sir John Herschel, and by M. Dové,[2] who constructed an induction balance, wherein two separate induction coils, each having its primary and secondary coils, were joined together in such a manner that the induced current in one coil was made to neutralise the induced current in the opposite coil, thus forming an induction balance, to which he gave the name of differential inductor. In those days physicists did not possess the exquisitely sensitive galvanometers and other means of research that we possess to-day, but sufficiently important results were

[1] "On an Induction-Currents Balance, and Experimental Researches made therewith." By Prof. D. E. Hughes. Read at the Royal Society, May 15.

[2] De la Rive, "Treatise on Electricity," vol. i. chap. v. (London, 1853)

obtained to prove that a vast field of research would be opened if a perfect induction balance could be found, together with a means of correctly estimating the results obtained. In experimenting with the microphone I had ample occasion to appreciate the exquisite sensitiveness of the telephone to minute induced currents. This led me to study the question of induction by aid of the telephone and microphone. The results of those researches have been already published.[1]

Continuing this line of inquiry, I thought I might again attempt to investigate the molecular construction of metals and alloys, and with this object I have obtained, after numerous comparative failures, a perfect induction balance which is not only exquisitely sensitive and exact, but allows us to obtain direct comparative measures of the force or disturbances produced by the introduction of any metal or conductor.

The instrument which I have the honour to present to the Royal Society this evening, consists (1) of the new induction-currents balance; (2) microphone, with a clock as a source of sound; (3) electric sonometer, or absolute sound measurer, a late invention of my own; (4) a receiving telephone and three elements of Daniells' battery.

In order to have a perfect induction-currents balance suitable for physical research, all its coils, as well as the size and amount of wire, should be equal. The primary and secondary coils should be separate, and not superposed. The exterior diameter of the coils presented this evening is 5½ centims., having an interior vacant circular space of 3½ centims., the depth of this flat coil or spool is 7 millims.

Upon this box-wood spool are wound 100 metres of No. 32 silk-covered copper wire. I use four of such coils, formed into two pairs, the secondary coil being fixed permanently, or by means of an adjustable slide, at a distance of 5 millims. from its primary; on the second similar pair there is a fine micrometer screw, allowing me to adjust the balance to the degree of perfection required.

These two pair of coils should be placed at a distance not less than 1 metre from each other, so that no disturbing cause should exist from their proximity.

The two primary coils are joined in series to the battery, the circuit also passing through the microphone.

In place of the telephone I have sometimes used a magnetic pendulum, the swing or the arc described indicating and measuring the forces.[2] I am at present engaged upon a very sensitive voltameter, which shall indicate and measure the force of rapid induced currents. The telephone, however, is well adapted as an indicator, but not as a measurer of the forces brought into action. For this reason I have joined to this instrument an instrument to which I have given the name of electric sonometer. This consists of three coils similar to those already described, two of which are placed horizontally at a fixed distance of 40 centims. apart, and the communication with the battery is so arranged that there are similar but opposing poles in each coil; between these there is a coil which can be moved on a marked sliding scale divided into millimetres; in a line with these two opposing primary coils, the centre coil is the secondary one, and connected by means of a circuit changing key with the telephone in place of the induction-balance. If this secondary coil is near either primary coil we hear loud tones, due to its proximity. The same effect takes place if the secondary coil is near the opposing coil, except that the induced current is now in a contrary direction, as a similar pole of the primary acts now on the opposite side of the induction-coil; the consequence is that as we withdraw it from one coil approaching the other, we must pass a line of absolute zero, where no current whatever can be induced, owing to the absolute equal forces acting equally on both sides of the induction-coil. This point is in the exact centre between the two coils, no matter how near or distant they may be. We thus possess a sonometer having an absolute zero of sound; each degree that it is moved is accompanied by its relative degree of increase; and this measure may be expressed in the degrees of the millimetres passed through, or by the square of the distances in accordance with the curve of electro-magnetic action.

If we place in the coils of the induction-balance a piece of metal, say copper, bismuth, or iron, we at once produce a disturbance of the balance, and it will give out sounds more or less intense on the telephone according to the mass, or if of similar sizes, according to the molecular structure of the metal. The volume and intensity of sound is invariably the same for a similar metal. If by means of the switching-key the telephone is instantly transferred to the sonometer, and if its coil be at zero, we should hear sounds when the key is up or in connection with the induction-balance, and no sounds or silence when the key is down or in connection with the sonometer. If the sonometer-coil was moved through several degrees, or through more than the required amount, we should find that the sounds increase when the key is depressed; but when the coil is moved to a degree where there is absolute equality, if the key is up or down, then the degree on scale should give the true value of the disturbance produced in the induction-balance; and this is so exact that if we put, say, a silver coin whose value is 115°, no other degree will produce equality. Once knowing, therefore, the value of any metal or alloy, it is not necessary to know in advance what the metal is, for if its equality is 115°, it is silver coin; if 52, iron; if 40, lead; if 10, bismuth; and as there is a very wide limit between each metal, the reading of the value of each is very rapid, a few seconds sufficing to give the exact sound-value of any metal or alloy.

During the course of these experiments with this instrument I noticed that my own hearing powers varied very much with state of health, weather, &c., that different individuals had wide differences of hearing, and that nearly in all cases one ear was more sensitive than the other; thus whilst my degree of hearing was 10°, another might be 60 in one ear and 15 in the other.[1]

Dr. Richardson, F.R.S., who upon my invitation investigated this subject, became so impressed with the value of the instrument as an absolute measurer of our hearing powers, and its capabilities of throwing much light upon its relation with health, that he has undertaken a series of researches which will extend over some time, and which I think, from some facts already gained, will be of great value to the medical profession. These experiments are now in his very able hands, and he will in due time announce the results to the Royal Society.

If an observer's hearing is limited to 10°, how can we hear results below this line? I should have stated that when used to measure the hearing power, we determine on a constant standard of force such as one element Daniell, but if we increase the number of elements we in the same ratio increase the inductive disturbance, and thus by a large increase of force bring within our range results too feeble to be heard without its aid, the sonometer constantly, however, giving the same degree for equality as the increased force is also used on this instrument. Thus in our measurements we can entirely neglect the amount of battery, as its comparative results remain a constant.

As a rule three Daniell elements will be found quite sufficient, and even this weak force is so exquisitely sensitive that it will find out the smallest fraction of difference in weight or structure of metals. Thus two silver coins such as a shilling, both quite new, and both apparently of the same weight, will be found to possess a

[1] *Comptes Rendus*, December 30, 1878, and January 20, 1879; Society of Telegraph Engineers, March 12, 1879.
[2] *Telegraphic Journal*, December 15, 1878.

[1] To this portion of my instrument when used as a measurer of our hearing powers, we have given the name of audiometer.

difference of weight which the instrument at once indicates.

The following experiments will show its exceeding sensitiveness and its wide field of usefulness as an instrument of research.

1. If we introduce into one pair of the induction coils any conducting body, such as silver, copper, iron, &c., there are set up in these bodies electric currents which react both upon the primary and secondary coils, producing extra currents whose force will be proportional to the mass, and to its specific conducting powers. A milligramme of copper on a fine iron wire, finer than the human hair, can be loudly heard and appreciated by direct measurement, and its exact value ascertained. We can thus weigh to an almost infinitesimal degree the mass of the metal under examination; for instance, if we take two English shilling pieces fresh from the Mint, and if they are absolutely identical in form, weight, and material, they will be completely balanced by placing one each in the two separate coils, provided that for these experiments there is an adjustable resting-place in each pair of coils, so that each coil may lie exactly in the centre of the vacant space between the primary and secondary coils. If, however, these shillings are in the slightest degree worn, or have a different temperature, we at once perceive this difference, and if desired, measure it by the sonometer, or, by lifting the supposed heaviest coin at a slight distance from the fixed centre line, the amount of degrees that the heaviest coin is withdrawn will show its relative mass or weight as compared with the lightest. I have thus been able to appreciate the difference caused by simply rubbing the shilling between the fingers, or the difference of temperature by simply breathing near the coils, and in order to reduce this sensibility within reasonable limits, I have only used in the following experiments 100 metres of copper wire to each coil and three cells of battery.

2. The comparative disturbing value of discs of different metals, all of the same size and form of an English shilling, and measured in millimetre degrees, by the sonometer, is the following:—

Silver (chemically pure) ...	125	Iron (chemically pure) ...	45
Gold ,, ,, ...	117	Copper (antimony alloy)	40
Silver (coin)	115	Lead	38
Aluminium	112	Antimony	35
Copper	100	Mercury	30
Zinc	80	Sulphur (iron alloy) ...	20
Bronze	76	Bismuth	10
Tin	74	Zinc (antimony alloy) ...	6
Iron (ordinary)	52	Spongy gold (pure) ...	3
German silver	50	Carbon (gas)	2

These numbers do not agree entirely with any lists of electrical conductivity I have yet met with; the numbers are, however, invariably given by the sonometer, and the divergence may be due to some peculiarity of structure of the metals when formed into disks. Future investigations with this instrument will, no doubt, give more correct values than I have been able to obtain with my limited means of research.

3. It will be seen from the above that the instrument gives very different values for different metals or alloys; consequently, we cannot obtain a balance by employing two disks of different metals, and the instrument is so sensitive to any variation in mass or matter that it instantly detects the difference by clear loud tones on the telephone. If I place two gold sovereigns of equal weight and value, one in each coil, there is complete silence, indicating identity or equality between them. But if one of them is a false sovereign, or even gold of a different alloy, the fact is instantly detected by the electrical balance being disturbed. The instrument thus becomes a rapid and perfect coin detector, and can test any alloy, giving instantly its electrical value. The exceeding sensitiveness of this electrical test I shall demonstrate by experiment this evening. Again, as regards coins, it resolves an almost magical problem. Thus, if a person puts one or several coins into one pair of coils, the amount or nominal value being unknown to myself, I have only to introduce into the opposite coils, different coins successively, as I should weights in a scale, and when perfect balance is announced by the silence, the amount in one box will not only be the same nominal value, but of the same kind of coin.

4. We find by direct experiment with this instrument that the preceding results are due to electric currents, induced by the primary coil, and that it is by the reaction of these that the balance is destroyed, for, if we take an insulated spiral disk or helix of copper wire, with its terminal wires open, there is no disturbance of the balance whatever, notwithstanding that we have introduced a comparatively large amount of copper wire; but on closing the circuit the balance is at once very powerfully disturbed.

If the spiral is a flat one, resembling a disk of metal, and circuit closed, we find that loud tones result when the spiral is placed flat, or when its wire is parallel to those on coils; but if it is held at right angles to these wires no sound whatever is heard, and the balance remains perfect. The same thing occurs with disks of all non-magnetic metals, and a disk of metal placed perpendicular to the coils exerts no influence whatever. The contrary result takes place with a spiral of iron wire or disk of iron, the induced current circulating in the spiral is at its maximum when the spiral lies flat or parallel with the coils, giving no induced current whatever when at right angles, but the disturbances of the induction-balance is more than four-fold when perpendicular to the wires of the coils, than when parallel with the same. That this result is simply due to the property of magnetic bodies of conduction of magnetism, we shall see in some following experiments.

That the currents in non-magnetic metals travel in a circle corresponding to that of the primary coil, may be seen with spongy gold. In its first extremely divided state it falls below our zero of hearing, on slightly shaking the bottle we have 2° as its value; on pressing it its value rapidly increases with the pressure, until when formed into a solid disk its value becomes 117°.

5. The instrument proves that a very remarkable difference exists in bars of iron of the same exact form and size, but of different provenance or treated in a different manner; in point of fact, no two bars, cut off of the same rod, and treated alike, are exactly of the same value, or induce a complete balance.

Mr. Stroh, the eminent instrument-maker, has kindly furnished me with numerous samples, varying in value in degrees of the sonometer from 100 to 160.

Chemically pure iron was found to be the best, but still very slightly superior to ordinary iron, which had been drawn into a wire of the required thickness. The fibrous condition thus developed being highly favourable (if softened by heat) for the conduction of magnetism. From numerous examples I select a few indicative values:—

	Softened.	Tempered.
Chemically pure iron	160	130
Forged soft iron	150	125
Wire-drawn iron	156	120
Cast steel	120	100

6. As yet the instrument has given no indications of molecular change produced by magnetism in non-magnetic bodies, but the great change which takes place in all magnetic bodies, except hard-tempered cast steel, indicates that a molecular change of structure, analogous to that of tempering, takes place upon iron, steel, and nickel.

If we place a disk of iron in one of the coils, we find that the balance is destroyed, and that the iron has weakened the induction by the absorption of work done in inducing

the circular currents. This can be perfectly balanced by placing a small coin or disk of silver or copper in opposite coils; but if an iron wire or rod is placed perpendicular to the coils, then increase of inductive force takes place in those coils by the conduction of induced magnetism from primary to secondary, and the iron can no longer be balanced by silver, copper, or any non-magnetic metal. The coils must be either removed farther apart, so as to reduce the increased force, or balanced by an equivalent amount of iron or magnetic conduction in opposite coils.

An interesting case of both reduction and increase of force in the same pair of coils occurs if we place a disk of iron, not in the centre of coils, but in the vacant space between the coils. We thus reduce the force by 150°. If, in addition to this, we place iron wires perpendicular and in the centre, there is increase of force, and if this increase is so proportioned as to be 150°, we immediately restore the balance, and we have here in the same coil two separate pieces of iron, each disturbing the balance and giving out loud tones, but producing no effect whatever, when both are introduced at the same time, complete silence being the result.

7. These coils prove what has already been long known, viz., that hard steel has a far less conducting power for magnetism than soft iron, although the hard steel has a far higher retaining power. This instrument demonstrates a point, which I have not yet seen remarked, that magnetism does not in itself change the conducting powers, but that it produces a molecular change of structure in iron, analogous to that of tempering; for if we balance two soft iron rods against each other, the balance being made perfect by the addition of fine iron wires on the weakest side, we find that on strongly magnetising this bar, by drawing it across a strong compound magnet, and on replacing it in its coil, it has lost 30 per cent. of its conducting power; or if, instead of magnetising we make this iron red hot and plunge it in cold water, the loss of conducting power will be very similar—25° to 30°. If these experiments are repeated upon various degrees of iron approaching steel in character, we find that as it already possesses hardness or temper, it is less and less affected by magnetism, until we arrive at hard cast steel, where magnetism no longer produces any change in its conducting powers. From this I draw the conclusion that the effect of magnetism is very similar to that of temper, and shall show under the effects of strain and torsion that magnetism produces this temper or strain perpendicular to the lines of magnetic force.

8. The instrument shows that a remarkable change takes place in the magnetic conducting power of iron and steel on subjecting the wire under examination to a longitudinal strain; for if we pass an iron wire through the centre of both coils, half a millimetre diameter and 20 centimetres or more in length, so arranged by a winding key that we can apply a strain to this wire, we find a magnetic conducting value, unstrained, of 100, but on applying a slight strain its value rapidly increases, being more than double at its breaking point. If during this strain we strike the wire, we hear its musical tone, and no matter how much we may wind or unwind it, provided we do not pass its limits of elasticity and similar wire is used, that the same musical tone will invariably give the same magnetic value. Thus the note A, or 435 complete vibrations per second, gave always the magnetic value of 160, or 60 per cent. increase of power over the unstrained wire. If whilst this wire is strained, giving the value 160, we magnetise it by drawing over it a strong compound magnet, the note remains the same, showing no difference of tension, but its magnetic value has fallen 80°, being now 80 instead of 160; and this wire can never again be brought by strain up to its previous high conducting powers. Now as we have seen that magnetism produces no change in hard tempered steel, but that it does so in soft iron very analogous to that of temper, and as the effect of strain would be also to harden the fibres by bringing them all parallel to the line of mechanical strain; and as this improves its conducting power, while magnetism instantly destroys all the benefits of the longitudinal mechanical strain, we can only draw the conclusion that magnetism produces a strain analogous to temper, but contrary to that of the longitudinal mechanical strain; in other words, that the magnetic strain is produced perpendicularly to its lines of force.

This view is sustained by the effects of torsion; for if, in place of straining the wire, it is twisted, instead of increasing, it rapidly decreases in magnetic conductive value, each turn or twist decreasing its power of conduction in a remarkable constant line of decrease. At eighty turns of this wire there was a decrease of 65 per cent.; at eighty-five turns the wire broke, and on testing it to see if magnetism had any decreasing effect on it, I found that it produced no change whatever; but this twisted soft iron wire had now remarkable permanent retaining powers of magnetism, being superior to tempered cast steel.

Again, if we take three similar pieces of soft iron wire, leave the first for comparison in its natural condition, strain the second by a longitudinal strain until it is broken, and twist the third by a torsion-key until it also is broken; we find on magnetising equally these three wires, and allowing ten minutes' repose, that the first or untouched wire has a retaining power of magnetism of 100, the second only of 80, and the third, or twisted wire, of 300. I hope by the light thus given soon to be able to produce a magnet whose force shall be greatly in excess of what we have hitherto possessed, our difficulty at present being that in order to temper steel we must heat it to redness, and this allows the molecules to rearrange themselves contrary to the object we have in view.

9. There is a marked difference of the rapidity of action between all metals, silver having an intense rapidity of action. The induced currents from hard steel or from iron strongly magnetised are much more rapid than those from pure soft iron; the tones are at once recognised, the iron giving out a dull, heavy, smothered tone, whilst hard steel has tones exceedingly sharp. If we desire to balance iron we can only balance it by a solid mass equal to the iron to be balanced. No amount of fine wires of iron can balance this mass, as the time of discharge of these wires is much quicker than that of a larger mass of iron. Hard steel, however, can be easily balanced, not only by steel but by fine iron wires, and the degree of the fineness of these wires required to produce a balance gives a very fair estimate of the proportionate time of discharge. The rapidity of discharge has no direct relation with its electrical conductivity, for copper is much slower than zinc, and they are both superior to iron.

10. The instrument shows a marked difference in all metals, if subjected to different temperatures. The value is reduced in non-magnetic metals, and this we should expect from the known influence of temperature on the electrical conductivity; but in the case of iron, steel, and nickel (as it has already been remarked by many), the contrary takes place, namely, a far higher degree of magnetic conductivity. A bar of soft iron, whose value at the temperature of the room, 20° C., was 160, became on heating it to 200° C., 300, that is to say, its value was nearly doubled. A bar of pure nickel, whose value at 20° was 150, became on heating it to 200°, 320; thus, in the case of nickel, its value for magnetic conductivity was more than doubled, and at this heat it surpassed the chemically pure iron at the same heat, giving a magnetic value of 320 against 300 for the iron, but at the normal temperature of 20° the iron had more magnetic power of conduction than nickel. Heating nickel by simply plunging it into boiling water increased its force from 150

to 250, plunging this same bar into ordinary cold water reduced its value to 130; thus the mere difference of the normal temperature of the air in the room and water which had been in this room some hours produced 20° of difference. In fact, I found that the radiant heat from the hand would raise the magnetic value several degrees, and thus nickel may be regarded as a magnetic thermometer far more sensitive than the ordinary mercurial centigrade.

The instrument also measures the electrical resistance of wires or fluids. In order to make it do this we have only to place the resistance to be measured across the two wires of one induction-coil and on the other known resistance units. In this way we can produce a perfect balance, for it then becomes an induction bridge, the results and modes of testing of which are somewhat similar to Wheatstone's bridge.

It measures also the electrostatic capacity of Leyden jars or condensers, and is sufficiently sensitive to appreciate and measure a surface of tinfoil not larger than four inches square, the condenser being simply placed between the wires of one pair of coils, and the disturbance produced being measured on the sonometer.

I could cite many more interesting experiments in other branches of physical research for which this instrument offers a wide field of observation; but my object this evening is neither to broach new theories nor to correlate at present the results obtained with views already advanced by Ampère and others.

My only desire has been and is to show the wide field of research the instrument opens to physical inquirers. I trust that in more able hands it may serve to elucidate many physical phenomena.

ON THE EVOLUTION OF THE VERTEBRATA[1]

III.

CROCODILIA.—The crocodiles form another group of reptiles which has become isolated from all the contemporary groups or orders. The most perfect antithesis of the bird, the crocodile, is, nevertheless, in essentials, in strict conformity with the bird pattern; or, rather, both it and the bird conform to the pattern of some ideal or vanished reptile.

This likeness can be shown in the body, but it is most evident in the head; although unlike the bird's skull in general specialisation, that of the crocodile is, in all essential respects and in numberless details, like that of a young bird. Compare the strong, solid, and dense skull of the crocodile, with its thick, pitted, and rugose bones, and accurate and dentated sutures, with that of a parrot, a toucan, or a hornbill—scarcely a suture left, the bone looking like polished ivory and the substance so completely spongy within that its weight is but little more than that of a few quills of the same bird. Yet these lightest and most delicate of all skulls had once all the sutures seen in that of the crocodile, and the two types of skull developed each "centre" in the same manner and on a similar model; in the middle of the incubating period they were so much alike that one diagram might have served to illustrate both.

In their covering, as well as in their general form, the crocodiles contrast strongly with the birds; instead of a soft plumage, often gorgeous in colour, they are invested with a coarse armour of segmental rows of rough plates of bone (dermostoses), coated over with horn. Representatives of the turtle's plastron are seen in the so-called abdominal ribs—which must not be confounded with like structures of the same name seen in the chamæleon and *Hatteria*—and in the inter-clavicle, which is fixed to the under-surface of the breast-bone.

The frame-work of the body is well ossified in the adult, and the vertebræ and ribs are very similar to those of a bird, the greatest difference being in the neck, which is much shorter and stouter, and has much larger rudimentary ribs, which remain permanently distinct. In the young of the *Ratitæ* (Emeu, &c.), however, all the cervical vertebræ except the atlas and axis, have a pair of ribs, which remain distinct for a considerable time in the upper part and permanently in the lower part. The crocodile's sacrum also, instead of being composed of a large number of joints, has merely two, that carry the pelvis, whilst the tail, instead of being arrested, as in living birds, is developed, as in the ancient *Archæopteryx*. The vertebræ of the crocodile are for the most part *procœlous* (concave in front and convex behind), and thus resemble those of the dorsal region of plovers, penguins, and some other water-birds. The setting in of the ribs and their overlapping (*uncinate*) processes are also similar to what is seen in birds.

The rhomboidal sternum is cartilaginous, and sends out behind a pair of *xiphoid* processes, being defended in front by the bony interclavicle, which is the counterpart of the leg of the Y-shaped merrythought of the fowl. The shoulder-girdle is composed of a pair of cartilages with a gentle curve and of a moderate width; each is ossified by two bones, an upper, the *scapula*, and a lower, the *coracoid*.

In the head, all distinction between dermal scutes and sub-cutaneous bones is lost; a thick web is ossified throughout, and has only left a thin layer of the skin soft, as a "quick" to the horny coat. From the snout to the exit of the optic nerves, the internal cranium is unossified, while the posterior part is well ossified, as are also the basal region up to the pituitary body, the capsules of the ear, and the alisphenoids. The labyrinth of the nose is very simple. A hard palate is formed by the maxillaires, palatines, and pterygoids, thus causing the nasal passages to open far back in the throat, this specialisation being of advantage to the crocodile while drowning his prey.

The structure of the organ of hearing agrees with that of the tortoises and the higher lizards, the drum cavity being formed inside the quadrate, into which an air-tube (*siphonium*) opens into the mandible, as in birds. The two drum cavities communicate in a passage running over the skull behind. A rudiment of this passage exists in birds, and in the higher kinds opens into the spongy tissue which lies between the two tables of the skull.

Birds.—The lower tentative forms of birds have for the most part evidently come and gone during the time the crocodiles have been in existence. The palæontologists, however, are beginning to show us how thoroughly intermediate between the true reptiles and birds the extinct birds of the chalk and the oolite were. The most ancient or generalised types of living birds, the ostrich tribe, are all incapable of flight, but the oldest bird known in the fossil state—*Archæopteryx*—was well fitted for flight.

Interesting connecting links between the ostrich tribe and the higher forms are seen in the southern world (*Notogæa*), where many of the birds have a much lower and more reptilian structure than their northern relatives, their power of flight being less, their brain smaller, and in many cases they are deficient in the inferior larynx or *syrinx*. Thus the South American *Tinamous*, which are intermediate between the ostrich tribe and the grouse, have a very small brain, and consequently such low intelligence that they have not the sense to use their own wings; moreover, their flesh resembles that of a reptile, they possess lacertilian super-orbital bones, and a considerable number of the sutures in the head remain permanently open. These birds do not so much resemble the South American Rhea as the Australian *Apteryx*, representative species being often found in these two regions which correspond with each other, but are far more ancient than, and do not correspond with, the types found north of "Wallace's Line."

[1] Abstract of Prof. Parker's Hunterian Lectures, delivered at the College of Surgeons, commencing on February 10. Continued from p. 64.

The influence of desert or prairie life has doubtless had much to do with the modifications found in the ostrich tribe; the principal of these modifications are, the abortion of the tail, the lessening of the wing, the huge increase in the size of the hind-limbs, and the suppression of unnecessary toes.

It is quite within the bounds of reasonable conjecture to suppose that from time to time great waves of morphological force, so to speak, and fresh revivals of life, passed over the old reptilian fauna, and that many kinds of the more ductile reptiles yielded to the influence of these waves. When, however, one member improved, the other members improved with it; the loss of digits and their claws, the sport that appeared in the exchange of feathers for scales, the increased solidity of the sacral region, and the tighter setting on of the hind limbs—these were only a few of the things that were correlated in this radical reform of the old reptilian types. The teeth were only slowly lost, as the invaluable papers of Prof. Marsh show. Epidermal imitations of teeth, however, occur in existing ducks and geese, and in the South American Passerine, *Phytotoma rara*, in which latter they are ossified from the jaw.

The hot condition of the bird's blood has much to do with the intensity and rapidity of its early metamorphosis. The time in which arboreal birds (*Altrices*) are ripened for hatching is marvellously short, and after this, in a single month, many of them have learnt their lesson in flying, and begin to be ready to migrate.

The segmented form of the simpler fish, or amphibian, is still to be traced in the bird. The embryo of the swan develops six dozen segments behind the head, twenty-five of which belong to the neck. Most of these segments can be traced in the adult, except those of the tail, the posterior ten of which, though separate at the time of hatching, grow together to form the plough-share bone, on which the tail-quills are set.

The endo-skeleton is greatly developed, and its ossification is carried to the utmost degree of perfection, only traces of cartilage persisting in the joints and often in the nose.

The outer skeleton may be divided into three categories. The first of these consists of the exuberant and unique growths of the epidermis—the feathers and quills, to which must be added the horny sheaths of the beak and the scaly coverings of the legs. The second consists of the overlapping series of cartilages that become ossified to form the limb-girdles from which the limbs grow out, and also a pair of sub-cutaneous cartilages in front of the head, which belong to the labial category, and sometimes there is one on each ramus of the mandible. The third takes in the sub-cutaneous bones that invest the proper endo-skeleton, whether bony or cartilaginous, and the ossified tendons and fasciæ (*aponeuroses*). There are three proper investing bones, as a rule, attached to the shoulder-girdle, which coalesce to form the greater part of the merrythought (*furcula*); these, as before mentioned, are the counterparts of the ventral splint-bones of Plesiosaurus and Hatteria, and their non-coalesced representatives are also seen in lizards and in the Monotremes. In the head there is a large number of investing bones, which, however, enjoy for the most part a very temporary independent existence.

The increased size of the brain-mass has given rise to a very different proportion of cranial to facial elements as compared with what exists in the reptile, and the process of ossification is carried to its utmost perfection. Except at the articular extremities of the bones, all the original cartilage rapidly disappears; this matrix is succeeded by marrow, which is in many cases completely absorbed, giving rise to air-cavities, which open into the nearest air-sac.

The endo-skeletal palatine bones are ossified to a great extent whilst the tissue is still formed of young and soft cells, before the solid hyaline cartilage has had time to grow, and in many passerine birds the exo-skeletal vomers are grafted upon a pair of cartilages, which, however, also belong to the outer skeleton. No true cartilage has yet been found in the outer ear. Rudiments of the hyoid and first branchial arch exist behind the lower jaw.

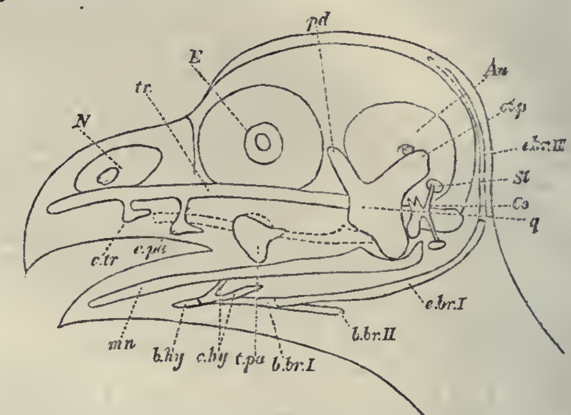


Diagram of the Chondrocranium of a Passerine Bird. *au*, auditory capsule; *b.br*, basi-branchial; *b.hy*, basi-hyal; *c.hy*, cerato-hyal; *c.br*, cerato-branchial; *co*, columella; *c tr*, cornua trabeculæ; E, eye; *e.br*, epi-branchial; *e.pa*, ethmo-palatine; *mn*, mandible; N, nasal capsule; *ot.p*, otic process; *q*, quadrate; *st*, stapes; *t.pa*, trans-palatine; *tr*, trabeculæ

The protrusible and retractile face of the bony fishes is constructed in a manner very similar to that seen in the hinged fore-face of a fowl or parrot; in these birds, as in the fishes, the pre-maxillaries push the maxillaries aside, cover them over, and keep them from the dentary edge, thus converting the bones usually so massive, into feeble "moustache bones" (*ossa mystacea*, Cuvier).

Mammals.—Such a hypothesis as that Nature bred either all her birds or all her mammals from one stock is at once upset by the facts presented by the structure of the lowest mammals—the duck-billed platypus and the echidna. Between the mammals and the types which foreshadow them, viz., the Selachians and the Batrachians, there is unfortunately a large chasm; and moreover, the platypus and echidna refuse to lie fairly in the direction indicated at the top of this chasm, as they confusingly partake of the characters of the reptile and bird; as well as those which are peculiarly mammalian.

The skeletal parts of the mammal are modified in a great number of ways answering to the great variety of their modes of life, and especially in regard to prehension and progression. In the higher kinds there are few or no subcutaneous bones (*parostoses*) in the body, but the head depends upon these for its construction as much as in the birds: where there are no clavicles there are no parastoses behind the head.

In the lowest forms (platypus and echidna) there are three clavicular bones; in the pangolin (one of the *Edentata*) the body is covered with large imbricated scales; the armadillos have strong body armour, which is both bony and horny, as in the tortoises and crocodiles, and in certain rodents, such as the South American *Cœlogenys* and *Lophiomys imhausii*, the bones of the head resemble very much the bony scutes of the lower types, for they become granular and almost ganoid on their outer surface. The endoskeleton and the overlying limb-girdles and limbs are developed to a perfection peculiar to the mammal, the culmination of which is seen in our own species.

Above the lowest forms, neither in the low marsupials nor in the almost equally low Edentata, do we find the middle collar-bone (inter-clavicle). Moreover, in the large Herbivora with a keeled chest, the paired clavicles also disappear; in man, monkeys, bats, moles, and shrews,

they have their largest development, but do not correspond merely to the paired bones of the lizard and platypus, being formed both of cartilage and bone as in the bird. The girdle of the hind-limb is of a more archaic and less metamorphosed pattern than that of the fore-limb; in man the pelvis corresponds very closely with the shoulder-girdle of the frog. The limbs agree nearly with the tailed amphibian pattern. The main modification of the spine is seen in the presence of inter-central pads or buffers of cartilage, and a pair of bony *epiphyses* to each centrum.

The skull is wrought into one strong, compact building, and the short, solid, lower jaw is articulated directly to the head; the *primary* lower jaw stops growing at a very early period of embryonic life, and then loses, by absorption, the Meckelian rod, which is, indeed, all the arch except its upper part; the working mandible is formed from superficial bone and cartilage, the prototypes of which must be sought amongst the lowest fishes. The upper part of the primary mandibular arch, which in the lower types gives rise to the quadrate, is now specialised to form the *malleus*, or the outermost bone of the chain of the middle ear. One principal external bone and sometimes an imperfect rudiment of one or two others appears on the inside of the primary lower jaw in the embryo, but these enjoy a very short separate existence. In the hyoid arch the upper element, or epi-hyal, is divided off to form the *incus*, the middle bone of the middle ear. The *orbiculare* is a further subdivision of the upper element, and the stapes is a part of the auditory capsule segmented off. The cochlea, which, in the Sauropsida, forms only part of a coil, is now perfected into a spiral chamber with several turns. The membrane of the drum lies at the bottom of a long tube, and is there stretched upon a bone which at first is a mere imperfect ring, but which afterwards grows out as the bony *meatus externus*. The *concha auris* is an opercular cartilage of the first cleft, the essential part of which is the *tragus*.

Outside the primary lower jaw, the two halves of which are confluent in front and below, there is a cartilage having the same relations as the *labial* of a shark; in the outside of this cartilage the *dentary* splint bone appears, and gradually converts it into bone, from before backwards. Throughout life part of this cartilage still remains, capping the convex hinge of the lower jaw; it is probable that the cartilaginous plate within the joint (*meniscus*) and the cartilage lining the temporal bone above, to finish the joint, are derived from the same source.

As already mentioned, the forecast of the mammalian type, which is very plain in the cartilaginous fishes, becomes much more plain, definite, and indubitable in the frog and toad. In fact, the building materials are passed from hand to hand, as it were, in this way: the batrachian forefathers brought down all things meet for the work, borrowing and taking cartilages from the Selachians, and bones from the Ganoids, and noiselessly forming them, after due selection, into a new, more compounded, and nobler structure.

The rude ancestors of the tribes that give suck began to build on this higher level, with these more varied or better-shaped blocks and plates; and by the infinite cunning, the effectual working of the morphological force, in due time the consummation was effected of vertebrate form. But the consummation of all, the election and selection, that has been going on since the beginning of the ages, is seen in man, who alone gives meaning to, and reads the meaning of, the whole mystery of organic life.

OUR ASTRONOMICAL COLUMN

THE OBSERVATORY OF MANNHEIM.—We have received from Prof. Valentiner, the successor of Prof. Schönfeld in the direction of the observatory at Mannheim, the third part of the "Astronomical Observations" issued from this establishment. The two former parts, published in 1862 and 1875, contained observations of nebulæ and clusters, but without micrometrical measures of the positions of the components of the latter objects; in the present part the two clusters Nos. 1166 and 4410 of Sir John Herschel's General Catalogue are specially treated upon, and the position of thirty-six stars in the former cluster and seventy-one stars in the latter have been determined by micrometrical reference to a number of stars the places of which have been fixed by meridian observations. In this work a filar-micrometer upon the Steinheil refractor has been employed, and both observations and reductions have been made with every care to secure a high degree of precision. Diagrams of the stars observed in each cluster are appended. It is intended to measure the clusters 1454 and 1119 of the General Catalogue in the same manner. Only by patient and accurate measures of this nature can we hope eventually to learn the internal structure of these systems. Prof. Valentiner has given full details of his observations and reductions, which may be advantageously consulted by any one proposing to enter upon similar work. The Mannheim Observatory not possessing a meridian-circle, he has had recourse to the assistance of other observatories—Berlin, Leyden, and Leipsic—for the accurate determination of the positions of his reference-stars.

TEMPEL'S COMET.—M. Raoul Gautier has circulated an ephemeris of this comet, founded upon a correction of his predicted elements from three observations by Dr. Tempel at Arcetri. The positions for May do not materially differ from those which have appeared in NATURE. The corrected orbit is as follows:—

Perihelion passage 1879 May 7·02 M.T. at Berlin.

	°	′	″	
Longitude of perihelion ...	238	11	30·1	From mean equinox 1879·0
,, ascending node	78	45	37·4	
Inclination	9	46	31·6	
Angle of excentricity	27	35	0·6	
Mean daily motion			593″·18	
Log. semi-axis major			0·517880	

THE MINOR PLANETS.—From the *Berliner Astronomisches Jahrbuch* for 1881, which is just published, it appears that of the 194 small planets discovered up to the end of March last, eighteen have been observed at only one opposition, one of the number being *Medusa*, which, if the elements so far determined can be relied upon, has a shorter period of revolution than any other member of the group, *Flora* coming next. Upwards of 150 pages are devoted to the elements and ephemerides of these bodies for 1879, forming the speciality of this publication, upwards of forty calculators in various parts of Europe and America taking part in this laborious work; seventy-one of the ephemerides are by Dr. Maywald, of Berlin, who has been long similarly occupied. As already stated this portion of the *Berliner Jahrbuch* has been sent out to observers in anticipation of the appearance of the volume. The circulars independently issued by Prof. Tietjen have kept astronomers informed as to elements and positions of the newly-discovered bodies.

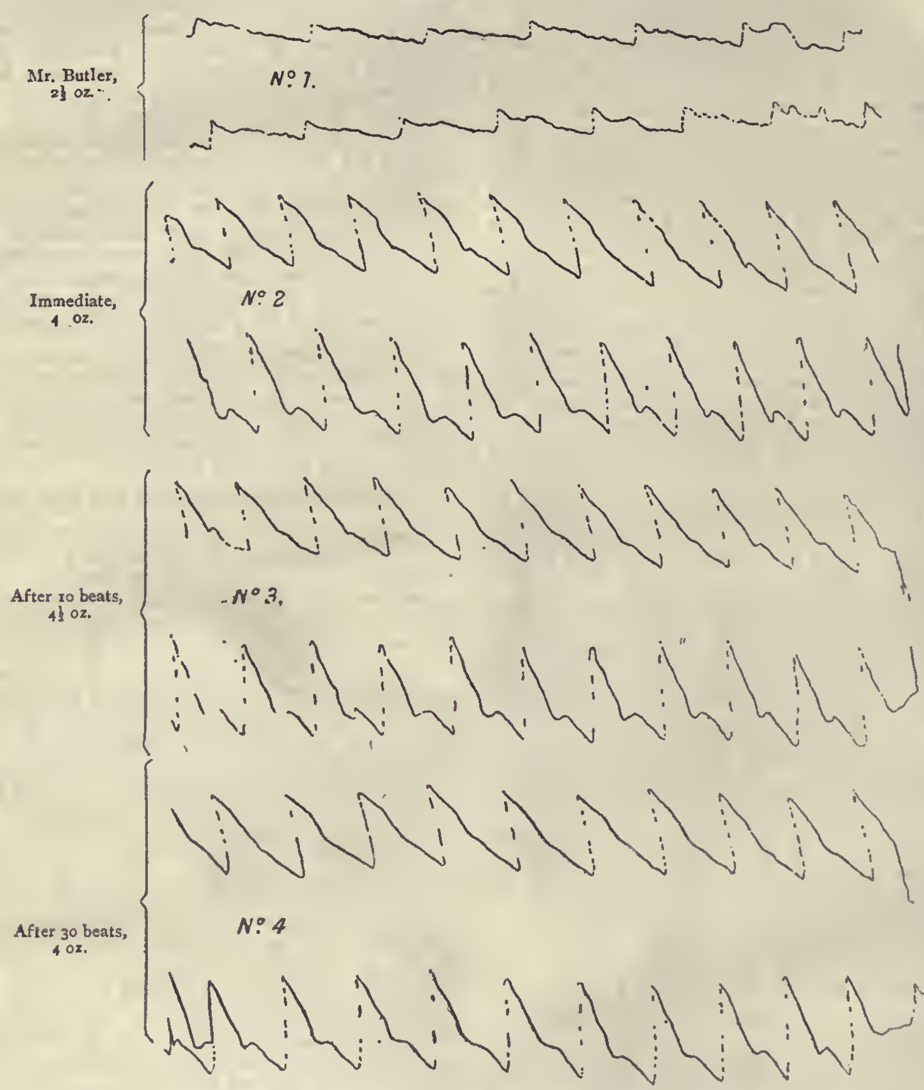
Prof. Peters, of Clinton, New York, announces his detection of a planet which, if new, will be No. 196.

THE OCCULTATION OF VENUS ON AUGUST 20.—On this date Venus, then at her greatest brilliancy, and so of crescent-form, will be occulted by the moon, which is also a narrow crescent at the time. The phenomenon would be one of much interest were it not that it is visible in a dark sky, only in the South Atlantic. If we calculate for the Royal Observatory, Cape of Good Hope, we find that the immersion takes place at 8h. 44m. mean time, but the planet will have set about five minutes previously, and in other parts of the South African Colonies, the occultation is similarly invisible. At St. Helena there will be no occultation.

A SPHYGMOGRAPHIC EXPERIMENT

AN experiment which I have recently been enabled to make by means of the sphygmograph may perhaps be of sufficient interest to deserve a brief record in your columns.

It occurred to me while preparing for the Croonian lectures, which I had the honour of delivering before the College of Physicians a few weeks back, that some light might be thrown on the movement of the blood in the vascular system, if an ordinary tracing of the healthy pulse were compared with one taken under different circumstances, wherein a large portion of the arterio-capillary network was thrown out of the circuit. By the kind assistance of my colleagues, Dr. Sharkey, Mr. Pitts, and Mr. Sandwith, I was able to put this hypothesis to the test, the result being the four pairs of tracings accompanying this communication. The patient in the first case (No. 1) was Mr. Butler, a pupil of the St. Thomas's Hospital, and in the last three instances one of the porters in this institution. The *modus operandi* was very simple. The sphygmograph having been firmly applied to the left



In all the tracings the lower is the normal pulse, the upper one with vessels compressed. Nos. 2, 3, 4, from the same patient, George Watts, æt 37.

radial pulse, a series of tracings was made to ascertain the pressure which produced the most characteristic curve-line. This proved in Mr. Butler's case to be two and a half, in that of the porter, four or four and a half ounces. This adjustment having been obtained, a normal tracing was taken on a broad slip of smoked plate glass at its lower portion. The three gentlemen above-named were instructed to compress simultaneously the two femoral arteries and the right axillary. A second tracing was then taken on the upper half of the same slip, so that it could be accurately compared with that already taken. Mr. Butler's pulse, even after it had been excited by the administration of a full dose of whisky (about three ounces), was too quiet and undemonstrative to give very striking results, though it will be seen that the excursion is diminished, the rate is rendered perceptibly slower in the ratio of six to seven, and the distinctive aortic notch is obscured by a number of smaller undulations. In the case of the porter we had to deal with an older man, of very muscular build, with a strong bounding, though not morbid pulse, who has been for some years in a Guards regiment. The first pair of tracings (No. 2) here showed a very important modification in the contour of the undulation. To eliminate any error due to a

merely transitory change, ten full pulsations were in the second case (No. 3) allowed to elapse after the complete closure of the three large vessels above-named, before the second tracing was taken, and in the third trial (No. 4) thirty beats were steadily counted with the vessels occluded, before the second tracing was obtained. Beyond this I did not feel justified in going, for fear of phlebitic or thrombotic accidents. It will be seen, however, that the change of character in the wave becomes decidedly more marked in each succeeding instance than in that preceding it. It consists roughly in the total obliteration of the dicrotic wave termed the "aortic notch." Accompanying this is an increase of rapidity and suddenness in the line of ascent, which, from being nearly vertical in the uncompressed, bends distinctly backwards in the compressed tracings, thus reproducing the circular arc in which the index of the sphygmograph travels. The latter fact might have been anticipated, but the former is curious, and I believe novel. The compressed tracings might be mistaken by an observer not acquainted with their mode of production, for those of a patient in whom the competency of the aortic valves was gravely impaired, and where the reflux of blood into the ventricle, which, in a healthy condition is prevented by their sudden closure, was freely taking place. On the plausible supposition that the dicrotic wave is a return undulation, a sort of echo sent back from the distal extremity of the arterial tree, it may be suggested that the great shortening thus artificially produced in the wave-length of the fluid undulation causes the primary and dicrotic waves to merge into one another.

I may say that neither of my patients felt any inconvenience from the experiment, either during compression or afterwards. An attempt was made to cut the internal iliacs also out of circuit by compressing the abdominal aorta before its bifurcation; but though to a good anatomist like Mr. Pitts the occlusion of this large vessel was not difficult, it caused so much hiccup and respiratory spasm as to render the continuity of the tracing uncertain.

W. H. STONE

THE ELECTRIC LIGHT

WE have already referred to the Albert Hall Exhibition, and its important bearing on the progress of electric lighting by bringing together the various methods by which it has been proposed to utilise electricity for this purpose. Since then the newspapers have brought us intimations of further progress which it is stated Mr. Edison has made, and as our readers doubtless know, he has taken out one or more patents for various alleged improvements. We have borne, and will continue to bear, willing testimony to the marvellous ingenuity of Mr. Edison in his application of various scientific principles, resulting in inventions that a year or two ago were scarcely dreamt of. We cannot but have the sincerest wish for Mr. Edison's success in whatever he puts his hand to; and his position as an inventor is so high that he needs not to take any trouble to make it more exalted by allowing exaggerated and misleading statements to go forth as to what he is about to do.

We have recently heard a great deal of Mr. Edison's experiments and promises with reference to the electric light. He startled the world in August last by announcing a great discovery which was to revolutionise the modes of artificial illumination at present in use, but we fear his discovery turned out to be something very like a *ridiculus mus*. Two of his patents have been published; one contains what we must deem a grave scientific error, the other the best authorities consider a mere reproduction of things that have been patented before by Staite, Harrison and others. Up to the present, so far as we can make out, he has done nothing new nor has he produced anything practical. The reports of newspaper interviewers are scarcely worthy of attention. Mr. Edison himself complains bitterly of their importunity and irrepressibility; but why, then, does he seem to stamp them with his approval by distributing their reports from his own laboratory? We cannot but think it a misfortune that he has kept at arms' length the electricians of New York, not one of whom, according to his own statement, has been allowed to enter his laboratory. We are therefore entirely dependent upon the New York press for our knowledge of his progress.

He has laid aside for the present his incandescent light and is experimenting with the Wallace form—his reason being that "everybody knows what the carbon lamp is, and besides it is not my lamp." He is engaged upon a new dynamo-machine—let us hope not his tuning-fork arrangement—but for what reasons he has put aside such perfect machines as the Siemens and the Gramme we are not enlightened. Dr. Hopkinson has recently shown that the Siemens' machine utilises 90 per cent. of the energy thrown into it. The Gramme is not far behind this. Mr. Edison can scarcely hope to improve on either. Again, the Brush and Wallace-Farmer machines are very efficient. Indeed, we scarcely want to improve the machine for producing currents. It is the lamp that needs the thought and work of the inventor, for no lamp yet exists worthy of the name.

The propagation by the daily press of scientific "discoveries" hot from the brain before they are allowed to be cooled down by the test of experiment is an invention upon which we cannot compliment our American friends. It does not conduce to the progress of science nor does it redound to the credit of the discoverer. We are accustomed on this side of the water to learn of new discoveries through the medium of well prepared and carefully digested papers submitted to one of our societies. There are such societies in America, but the records of such societies have to be searched in vain for any experiments or discoveries of Mr. Edison. We think it is matter for sincere regret that he prefers to promulgate what he conceives to be new through "our special correspondent," and the science dished up by these gentlemen is something wonderful to read. Thus says one paper:—

"Being questioned as to the subdivision of the electric light, the inventor said: 'The question is very simple. If you take a lamp in which the voltaic arc is produced from two carbon pencils, the more current you put on the faster the pencils are consumed and the resistance offered is lessened. There necessarily results a great waste of power. If the lamp is limited to 250-candle-light, it costs too much. By my plan the resistance is almost entirely at the lamp. The resistance of the conductor is to the resistance of the lamp as 1 to 100. The resistance of my lamp is as 192 against 1 to the resistance of the carbon lamp. You may consider the question most intelligently by taking a gas-burner as an example. If you have a half-inch gas-pipe and light the escaping gas without putting on a burner, how much gas-light can you get from an adjoining burner? Very little. But if you put in the half-inch pipe a burner, with a pin-hole in it, you get a light without interfering with other burners. The same condition obtains in electric lighting. The carbon lamp represents the half-inch gas-pipe; the pin-hole burner represents my lamp.' 'But is not the electric current exhausted, not with regard to the resisting agent, but according to the square of the distance travelled?' 'No. If you are supplying a mile of wire and then add another mile, the current will be weakened equally throughout the whole line, but not to that extent. If you keep on extending your line, you will have to make your conductor thick and add more power.' 'How do you propose to carry this theory into effect?' 'I shall have, proceeding from the central station, where a steam-engine and a series of dynamo-machines are placed, a

cable, say about an inch in diameter, composed of copper wires, each about one-sixteenth of an inch in diameter. The cable will be laid in a trench immediately under the flagging of the side walk, and near the curb; every twenty-five feet a wire will be dropped to carry the current into a house, and when the terminus of the cable is reached there will be one wire left. Of course it will be necessary to construct the cable according to the number of houses in each district. As a district increases in population the flagging can be taken up, and a section of cable can be placed alongside the original cable, and joined to it at each end. Thus the new houses can be supplied.' 'Will there not be a loss of electricity by induction or the influence of the earth?' 'None whatever. And now I will tell you another thing. It is perfectly easy for me to get a light equal to sixty-six candles from each of my lamps: but I limit them to six.' 'Will not the construction of your station and your cables be very costly?' 'No; and if it were, the profits would warrant the outlay.'"

Copper wires one-sixteenth of an inch in diameter—the same size as those often used for telegraphic purposes—are to convey currents of electricity to light up lamps whose resistances are as 192 to 1 as compared with carbon, or as 100 to 1 as compared with the conductor. The resistance of the copper wire is about 13 ohms per mile. What current will be required to produce a light of 66 candles a mile off under such conditions? An electromotive force of a 1,000 volts would not do it, and the very best machines do not much exceed 100 volts in this respect. Where is the power to come from? Mr. Edison now proposes to have 30 of his new dynamo machines worked by his 80-horse-power steam-engine, lighting up 400 lights. In other words, each machine is to produce about 13 lights, and to absorb $2\frac{2}{3}$ horse-power. This shows that his experience is gradually bringing him down to the limits of our experience in France and England, where for some time past one machine lights up twenty lights, but with an expenditure of 23-horse power. It also shows that he was premature in announcing the solution of the indefinite subdivision of the light, and tha he would have done well to have worked upon the expet rience of others rather than have learnt that experience himself by an immense expenditure of time and money. The electric light, theoretically and practically, is unquestionably more advanced in Europe than it is in America. But even here the progress in lamps is very slight.

Col. Bolton, in a remarkable paper read at the last meeting of the Society of Telegraph Engineers, has shown that electric light manias are not only periodic, but that the very same inventions are to a certain extent, also periodic. Thus he showed that everything that Mr. Edison has patented has been patented before in England.

NOTE AS TO DISTINGUISHING CHARACTERISTICS FOR ILLUMINATED BUOYS

THE plan of illuminating by means of Pintsch's system of forcing gas into floating buoys having now been tried by the Trinity House and by the Harbour Authorities of the Tay, I have lately been engaged in considering the best means of distinguishing one buoy from another.

The plan which occurred to me was *to make the flow of the gas produce automatic intermittent action*, and for this purpose some form of gas meter seemed to promise best. I applied to Messrs. Milne, gas engineers, Edinburgh, to give me their assistance in the matter, and they have succeeded in making a modification of a dry meter which has been tried and found to work very satisfactorily. By this arrangement a small supply of gas keeps a small jet constantly illuminated a little above the principal burner, and when, by the valve, the full supply of gas is turned on to the large burner, it is ignited by the small jet. The periods of light and darkness can be regulated in any desired proportion. The same object may, however, be effected by means of a single burner, the jet being kept burning in the socket.

By means, then, of two separate lanterns, one of which has red panes, and the other either white or green, the following characteristics may be produced :—

Red and white.
Red and green.
Green and white.

If, again, only one lantern be used, we shall have—

Intermittent white.
" red.
" green.

And if to these we add the present single fixed white, red, and green, this would give in all nine characteristics, which would probably be sufficient for any navigation.

It is proper to add that, in order to prevent oscillations of the apparatus, which would take the light out of the sailor's vision, the apparatus and burner should be made to work in gimbals, as in my steamer's lights. If these gimbals were made hollow, the gas could be easily made to pass up to the burner, but a simpler mode would be to use a flexible tube between the regulator and the burner.

THOMAS STEVENSON

GEOGRAPHICAL NOTES

LETTERS from Nordenskjöld have been received by the Governor-General of Siberia. They confirm the news already brought to Europe. The *Vega* steamship has been blocked by ice in a harbour named Kamen, at a short distance from Behring Straits on the east coast of Siberia. This station is easily reached by whalers every year. No doubt the escape of the explorer and his companions will take place without difficulty as soon as the ice breaks up, probably in a few weeks. The news has been brought by native messengers, and everything was going on well on board the *Vega*.

M. WOEIKOF has sent to the French Geographical Society a long and exhaustive memoir on the Oxus question. After having studied the question on the spot, the Russian geographer feels certain that the suppression of the Caspian mouth was produced not by a gradual elevation of the country, but by the accumulation of deposits in the bed of the river, and the immense drainage produced by the development of irrigation in the Khivan Oasis. He feels certain that the restoration of the former state of things would be a very easy work. It would result in the establishment of a new oasis between Khiva and the Caspian Sea. The Oxus being navigable to Balkh, and the Volga being in direct communication with the Baltic, through a system of canals, a water-way would thus be established from St. Petersburg to Balkh, and the stream would connect the Russian capital with the vicinity of their scientific frontier of India. M. Woeikof supposes justly that the restoration of the Oxus to the Caspian would accelerate the retreat of the Aral waters. He believes that shortly after that large operation the area of Aral would be reduced to one-third of its present extent. But he argues that this alteration would not be altogether detrimental to the prosperity of the surrounding countries.

THOUGH there are no journeys of discovery into the interior to record, some useful geographical and topographical work was done in Western Australia by the Surveyor-General's department during the last six months of 1878, as we learn by a report just received from Perth. The position of Mount Welcome at Roebourne, on the north-west coast of the colony, was determined to be

about S. lat. 20° 46′ 6″, E. long. 117° 7′ 55″. The courses of the following rivers were correctly traversed and mapped:—De Grey River, 100 miles; Turner, 25 miles; Yule, 50 miles; Sherlock, 50 miles; Fortescue and tributaries, 300 miles; Robe, 50 miles; Cane, 70 miles; Ashburton and tributaries, 150 miles; making a total of 795 miles. The heights of mountains have not yet been calculated, but a triangulation was made of the country between the De Grey and Ashburton Rivers, covering an area of 30,000 square miles. Maps of the districts above-mentioned are in preparation, but are not yet completed. The report of the work performed during the current half year will, no doubt, contain some interesting information, as a party, under the command of Mr. Alex. Forrest, started in January last to undertake the exploration of the previously unexamined tract of country in the north-west lying between the De Grey and Victoria Rivers.

BARON VON MÜLLER, in a letter to Petermann's *Mittheilungen*, states that Mr. Tietkens, who accompanied Giles on his two last journeys, has left Adelaide for Beltana at the head of a camel expedition fitted out by Mr. Elder for exploration along the region lying inwards from the great Australian Bight. Mr. Tietkens informed us when he was in this country that he was confident that long stretches of fine pasture-land would be found at various parts of this region, and one of his objects is apparently to find these. Baron von Müller speaks highly of Mr. Tietkens's qualifications as an explorer and surveyor, and expects that in the course of the next few years he will do much to add to our knowledge of the geography of the Australian interior.

M. SOLEILLET, the French explorer of North Africa, has arrived at Marseilles from St. Louis, in Senegal. He has been received by the Geographical Society of that city, and will deliver a lecture on the necessity of opening the way between Senegal and Algeria, *viâ* Timbucktoo. It is said that he will, at the suggestion of *Akhbor*, be called to Algiers by the Governor-General before going to Lyons and Paris, where he will deliver lectures on the same subject. In this connection we may state that an interesting ceremony will take place in a few days. The inhabitants of a small country place in the Eure department will remove to another site the grave of René Caillet, the celebrated Timbucktoo explorer, who died in 1838, and was the first laureate of the French Geographical Society. The Society will bear the expenses of exhumation, and send delegates to witness it. One of them will be M. Soleillet.

IN No. 20 of *Globus* of this year is a short article of some interest showing the physical and moral changes in the population of Siberia by the mixture of Russian colonists with the native races.

WE take the following from the *Gardeners' Chronicle*:—Mr. Goldie, the naturalist, who has passed the last eighteen months in New Guinea in search of plants for Mr. B. S. Williams, of Holloway, has, the *Brisbane Courier* states, collected an immense number of animals, birds, and insects, besides valuable botanical specimens, and believes that a large number of these are entirely unknown. He claims to have found an entirely new species of kangaroo. He has brought with him a native from the coast tribes, a good-looking lad of indistinct Malay origin, whose long frizzly hair, tied round with a string, is worn standing straight up. The natives of the inland tribes Mr. Goldie states to be entirely different from those on the coast in both appearance and customs, but all, he says, are friendly and good-natured, and not given to the deeds of ferocity lately detailed by us on the authority of the residents at a *bêche-de-mer* station. Mr. Goldie was of the party that made its way to the coast, crossing about twenty flooded rivers, and losing horses and baggage, and states that although they crossed some high ranges they never reached the dividing range, on the other side of which, the general belief amongst the party was, that payable gold would be found. The natives in the interior are, it appears, so awed at the sight of a white man as to obviate any risk of molestation. The custom of a tribe with whom Mr. Goldie's party came in contact, suggested to them the probable origin of the rumours that have been always current of a race of tailed men in some remote corner of the globe. These natives wear artificial tails of such cunning construction as to entirely mislead a casual observer. They are entirely naked, except for the caudal ornament, which is a plait of grass fastened round their loins by a fine string, and depending behind to about half-way down their legs. Possibly the missing link that has so baffled Darwin has only lately become extinct in New Guinea, and these descendants, ashamed of their degeneracy, keep up the tradition of a noble ancestry by simulating their distinguishing characteristic.

THE Austrian *Monatschrift für den Orient* of May contains an article of much practical and some ethnological value on the Nations of the Turkish Empire as factors in the National Economy; he reviews the condition of the various industries, and the character of the various ethnical elements of the Turkish dominions. Herr A. von Wassberg contributes a paper on the Migrations of the Inhabitants of the Ionian Islands, while Herr Schick continues his elaborate papers on Agriculture in Palestine.

THE May number of Petermann's *Mittheilungen* gives the chief place to a long and careful article by M. Lindeman on the North Coast of Siberia between the Mouths of the Lena and Behring Straits. Herr Lindeman traces the history of exploration in the region from 1630 to the present time, and follows this with a description of the coasts and islands. The article is accompanied by an excellent map in two sheets. Dr. Emin Bey, Governor of the Egyptian Equatorial Provinces, contributes an interesting Journal of a Journey from Mruli to the chief town of Unyoro, abounding with valuable notices on the country and people.

THE March number of the *Bulletin* of the Paris Geographical Society contains, as its first article, the first part of a learned paper by M. de Saulcy on the cities of Upper Louten, the Syria of the Ancient Egyptians. Other papers are on the frontiers of Russia in Central Asia, by M. de Ujfalvy; explorations of the Cunene, by M. Nogueira; and the dried-up rivers of the Dobruja, by Herr F. Kanitz.

NOTES

THE University of Cambridge proposes to confer the honorary degree of LL.D. upon the following, among others:—Mr. Justice Grove, Mr. W. Spottiswoode, President of the Royal Society, Mr. Henry J. S. Smith, Savilian Professor of Geometry, Oxford, Prof. Huxley, Mr. H. C. Sorby, F.R.S. The Rede lecture will be delivered in the Cambridge Senate-house at 2.30 on Wednesday, June 11. The lecturer, the Rev. W. H. Dallinger, has chosen the following subject:—"The Origin of Life as illustrated by the Life Histories of the Least and Lowest Organisms in Nature."

THE Forty-Ninth Annual Meeting of the British Association will commence at Sheffield on Wednesday, August 20, 1879. The President Elect is Prof. G. J. Allman, LL.D., F.R.S., Prof. L.S. Vice-presidents Elect—His Grace the Duke of Devonshire, K.G., F.R.S., the Right Hon. the Earl Fitzwilliam, K.G., the Right Hon. the Earl of Wharncliffe, W. H. Brittain (Master Cutler), Prof. T. H. Huxley, Sec. R.S., Prof. W. Odling, F.R.S. General Secretaries—Capt. Douglas Galton, C.B., F.R.S., Philip Lutley Sclater, Ph.D., F.R.S. Assistant

Secretary—J. E. H. Gordon, B.A. General Treasurer—Prof. A. W. Williamson, Ph.D., F.R.S. Local Secretaries—H. Clifton Sorby, F.R.S., J. F. Moss. Local Treasurer—Henry Stephenson. The following are the sections and their presidents:—A.—Mathematical and Physical Science.—President: George Johnstone Stoney, F.R.S. B.—Chemical Science.—President: Prof. James Dewar, F.R.S. C.—Geology.—President: Prof. P. Martin Duncan, F.R.S. D.—Biology.—President: Prof. St. George Mivart, F.R.S. E.—Geography.—President: Clements R. Markham, C.B., F.R.S. F.—Economic Science and Statistics.—President: G. Shaw Lefevre, M.P., Pres. S.S. G.—Mechanical Science.—President: J. Robinson, Pres. Inst. Mech. Eng. This list of sectional officers will be completed and will be submitted to the General Committee on Wednesday, August 20. The Reception Room will be opened on Monday, August 18, at 1 P.M., and on the following days at 8 A.M., for the issue of tickets to Members, Associates, and ladies, and for supplying lists and prices of lodgings, and other information, to strangers on their arrival. No tickets will be issued after 6 P.M. Tickets for the meeting may also be obtained from August 1 until August 6, on application to the General Treasurer, Prof. A. W. Williamson, British Association, University College, London, W.C. The first General Meeting will be held on Wednesday, August 20, at 8 P.M., when Dr. William Spottiswoode, Pres. R.S., will resign the chair, and Prof. G. J. Allman, F.R.S., President Elect, will assume the Presidency, and deliver an address. On Thursday evening, August 21, at 8 P.M., a *soirée;* on Friday evening, August 22, at 8.30 P.M., a discourse by William Crookes, F.R.S., on Radiant Matter; on Monday evening, August 25, at 8.30 P.M., a discourse by the Rev. W. H. Dallinger, on the Life Histories of the Minutest Organic Forms, and their Bearing on the Doctrine of the Origin of Species; on Tuesday evening, August 26, at 8 P.M., a *soirée;* on Wednesday, August 27, the concluding General Meeting will be held at 2.30 P.M. On Saturday evening, August 23, W. E. Ayrton, Esq., will deliver a lecture to the Operative Classes, on Electricity as a Motive Power. Tickets can be purchased of the local Secretaries. No report, paper, or abstract can be inserted in the Report of the Association unless it is in the Assistant Secretary's hands before the conclusion of the Meeting. A room will be provided for the reception of apparatus and specimens illustrative of papers communicated to the Sections. Excursions to places of interest in the neighbourhood of Sheffield will be made on Thursday, August 28.

WE regret to hear of the decease of M. Edouard Pictet, of Geneva, at the early age of forty-four. He was the son of Prof. F. J. Pictet, of the same city, formerly a writer on neuropterous, insects, latterly a palæontologist, who died about seven years ago. M. E. Pictet inherited his father's scientific tastes, and in 1865 published a "Synopsis des Névroptères d'Espagne," based upon a journey made in that country a few years previously. Latterly he had been much occupied in investigating the physical conditions of the Lake of Geneva, in company with Forel and others of his compatriots; and his official duties, municipal and otherwise, took up much of his time. He visited London at the time when the Loan Exhibition of Scientific Instruments was on view at South Kensington. The family Pictet has included amongst its members several illustrious scientific men, and is one of which Switzerland is justly proud. M. Raoul Pictet, the celebrated investigator of the liquefaction of gases, is a cousin of the subject of this note, and M. H. de Saussure also belongs to a collateral branch of the same family.

THE death is announced of Mr. Thomas Wills, F.C.S., who has acted as secretary to the Chemical Section of the Society of Arts since it was first founded in 1874. Mr. Wills was born in 1850, in Devonshire; he was educated at University College School and at King's College. In the early part of 1868 he became an assistant to Dr. Odling at St. Bartholomew's Hospital, and in the latter part of that year, on Dr. Odling being elected to the Fullerian Professorship at the Royal Institution, Mr. Wills was appointed his official assistant. In 1873 he resigned this post to accept the position of Demonstrator in Chemistry at the Royal Naval College. The subject to which Mr. Wills specially devoted himself was the application of chemistry to the manufacture of gas, and on questions connected with this subject he was rapidly becoming an authority. He was a constant contributor to the *Transactions* of the Chemical and other societies. For several years he acted as secretary to Section B (Chemistry) of the British Association, and he was a member of the Association Committee for ascertaining the best methods of improving the illuminating power of coal-gas. His most recent piece of work was in connection with the subject of electric lighting. Dr. Tyndall, in giving evidence upon the electric light before a Committee of the House of Commons, referred to Mr. Wills as having discovered that oxides of nitrogen were given off by the voltaic arc, thus rendering the light to that extent injurious.

IN the Paris Academy, Dr. Oppolzer has been elected a Corresponding Member in the Astronomical Section in place of the late Prof. Argelander, and M. Alphonse Favre in place of the late Prof. Leymerie in the Section of Mineralogy.

THE professors of the Museum of Paris have presented two candidates for filling the place vacated by the death of Claude Bernard, who was professor of general physiology in the establishment. The first candidate is M. Boubez, of the Institute, and the second M. Moreau.

A GENERAL MEETING of the Mineralogical Society of Great Britain and Ireland will be held at the Meteorological Office, 116, Victoria Street, on Tuesday, June 3, at 8 P.M., when the following papers will be read:—On abriachanite, a new Scottish mineral, by Prof. M. F. Heddle and D. W. H. Aitken; on haughtonite, a new mica, by Prof. M. F. Heddle; on christophite from St. Agnes, Cornwall, by J. H. Collins, F.G.S.; minerals from Japan, by John Milne, LL.D., and T. Davies, F.G.S.; additional note on penwithite, by J. H. Collins, F.G.S. The chair will be taken by Prof. T. G. Bonney, M.A. Other communications intended to be read at this meeting should be sent to J. H. Collins, secretary, at the Scientific Club, 4, Savile Row, London, W., not later than Saturday, May 31.

THE first public act passed by the U.S. Congress during the present session, was one making an appropriation of 200,000 dollars for the construction, under the direction of the Secretary of the Treasury, for the National Board of Health of a vessel provided with suitable refrigerating apparatus, for the purpose of determining the possibility of destroying the yellow fever infection by intense cold. The act as first introduced had special reference to the apparatus of Prof. Gamgee, but as passed it is within the power of the Secretary to select any device that will, in the opinion of the National Board of Health, best answer its purpose.

PROF. DUGES, of Mexico, in a recent letter to the Smithsonian Institution, speaking of the enormous numbers of the common cow-bird, or *Molothrus pecoris*, in his neighbourhood, refers to a certain flight supposed to have been about 12,000 yards in length, six yards wide, and probably over a yard deep. He estimates the number contained in it to be from 9,000,000 to 10,000,000. A flock of 1,000 or 2,000 of these birds is very common, generally mixed with the *Xanthormus icterocephalus*, and to some extent with the red-winged blackbird.

WE learn that Dr. Edouard Bornet, of Paris, eminent for his researches on the structure and reproduction of algæ, and author

of other works on that order, and Prof. Heinrich Gustav Reichenbach, fils, Director of the Botanic Gardens, Hamburg, alike distinguished for his special knowledge of, and publications on, the Orchidaceæ, have been elected Foreign Members of the Linnean Society.

OF eleven female candidates who presented themselves for the first examination for the degrees of London University, six were placed in the division of honours, four were declared to be entitled to exhibitions, and one was second in the whole list of candidates. There were only two failures.

DR. SWAN M. BURNETT, of Washington, has recently made some examinations for the purpose of ascertaining whether the negro in the United States is affected with colour-blindness to the same degree as the white race. He has examined 3,050 coloured children, from six to eighteen years of age, in the public schools of the district of Columbia, of whom 1,359 were males, and 1,691 females. Of these, twenty-two boys were colour-blind (or 1·6 per cent.), and two girls (or 0·11 per cent.) The percentage of colour-blindness among the whites in an aggregate of about 40,000 examinations is 3 per cent. for males, and 0·26 for females. The negro appears, therefore, to be less liable to this defect than the white race. The examinations were made in strict accordance with the plan proposed by Prof. Holmgren, of Upsala, Sweden, and used so extensively in making similar examinations in Europe.

A NUMBER of Jablochkoff candles have been employed by the French government, for illuminating, by night, an exhibition held at the École des Beaux Arts, for the benefit of schools. The success is so great, that it has been proposed by M. Turquet, Director of Fine Arts, to open by night the exhibition of Pictures, held now at the Palais de l'Industrie. It is stated that not less than 250 candles will be lighted on this occasion, which will require an engine of more than 300 horse-power. But the expense, although considerable, will be nothing in comparison with the receipts expected. The arrangements will be made during the temporary closing at the end of May, and the electric light be put in operation during the month of June. It is likely that the arrangements will be utilised by the Exhibition of Arts applied to Science, which will be held from July to November.

THE select committee to investigate into the explosion on board Her Majesty's armour-plated turret-ship *Thunderer* propose to make their experiments in the most public manner, in order fully to establish the stability of the guns constructed on the Woolwich system under all the conditions of the service, and the liability of any gun to be destroyed by unfair means. The burst gun has been taken into the inspection department for examination, and the sister 38-ton gun will be taken to the proof butts in the marshes to be fired.

THE June *Scribner* will contain the first of a series of articles on "Edison and his Inventions," by Mr. Edwin M. Fox. The opening paper will be devoted to the electro-motograph and its applications. The six-years' growth of this remarkable invention will be described by Mr. Fox with much incidental light on the inventor's methods of work.

THE *Colonies and India* furnishes some interesting particulars respecting the so-called "vegetable ivory," which is now so much used as a substitute for ivory. The vegetable ivory nut is the produce of a species of palm found wild in South America and Africa. Inside the hard shell is the white kernel, which being softer than ivory and easily carved, as well as readily dyed, and being less brittle than bone, is largely used in making buttons, &c. The unripe fruit consists of a green shell, containing a watery fluid, which, as the nut ripens, gradually thickens until it becomes a pulpy mass, and eventually hardens into solid matter. The water, though bitter to the taste, is wholesome, and often renders invaluable service to travellers, who cannot otherwise obtain water to drink. The tree (*Phytelephas macrocarpa*) on which the fruit grows is unlike an ordinary palm, having little or no stem and drooping downwards, especially when the weak branches are overweighted by the six or seven bunches of nuts, each containing six or seven seeds, inclosed in thick heavy shells and outer sheath, and weighing altogether from 20 to 24 lbs.

A RECENT valuable memoir by Prof. Stefan to the Vienna Academy treats of the relation between radiation of heat and temperature. In the first part he discusses Dulong and Petit's experiments, from which the conclusion was drawn that the amount of heat radiated from a body increases in a geometrical progression, when its temperature increases in an arithmetical. Prof. Stefan points out that the observations of these physicists may be calculated with great approximation by another very simple formula, according to which the amount of heat radiated from a body is proportional to the fourth power of its absolute temperature. It is shown that while the law of geometrical progression corresponds to Dulong and Petit's numbers better than that of the fourth powers, these numbers (because of defects in experiment) are not suited for rigorous proof of the law as to heat radiation. Further, it is shown that the formula of the fourth powers agrees with the observations of Provostaye and Desains much better than that of Dulong and Petit. In the second part of the memoir, cooling experiments are utilised for determination of heat-radiation in absolute measure. In the third it is shown that the formula of the fourth powers agrees fairly well with Draper's experiments on heat radiation of a glowing platinum wire, and Ericson's on that of a glowing block of iron. The fourth part contains some remarks on the sun's temperature. From the intensity of solar radiation as determined by Pouillet, the emissive power of the sun being considered = 1, we obtain, according to the formula of the fourth powers, the sun's temperature = 5580°. Nearly the same number comes by this formula from Soret's comparative determinations of the radiation of the sun and that of a glowing disk of zirconium.

A NEW grass, *Reana luxurians*, has been imported into Ceylon from Java, and is stated to be doing well, having attained a height of 8 feet in three months. It is said to contain a large amount of saccharine matter, and cattle and horses eat it freely.

EXTRAORDINARY finds of gold have lately occurred in the gold-fields of Dutch and French Guiana and are causing great excitement.

A RICH deposit of lead and silver has just been discovered near the Thames River, New Zealand. The ore is reported to contain 50 per cent. of lead, with about two pounds worth of silver, and 9 dwt. 13 grs. of gold per ton.

ACCORDING to the Japan papers, a singular innovation has lately taken place in an ancient branch of the trade of the country. Mixadzu, a town in the province of Tanbano-kuni, has always been famous for the manufacture of crape, the principal industry in the province. Hitherto, however, the crape has been manufactured from Japanese silk, but it has recently been discovered that the kind of silk required can be imported from Corea of better quality and much cheaper than it can be procured at home. A number of Japanese merchants have, therefore, formed themselves into a company with the object of manufacturing crape from Corean silk, and have already despatched one of their number to Corea to make the necessary arrangements.

ON Tuesday last week an enormous avalanche descending from the Jungfrau swept through the valley of Stufenstein, carried away a whole forest, and created the utmost consternation in the neighbourhood. So far as is known no lives were lost.

THERE has been a slight eruption of Vesuvius for some days.

A VERY distinct Fata Morgana was observed above the village of Zhor, near Kozlau in Bohemia, on the 2nd inst.

M. JULES FERRY, the French Minister for Public Instruction publishes a report on the re-establishment of the Museum of Pedagogy, which was created by M. Jules Simon at the Ministry of Public Instruction, and described in NATURE at the time. This report shows that the original idea of such a collection must be attributed to M. Jullien of Paris, one of the best pupils of the celebrated Pestalozzi, who established it in 1817. The direction of the new museum will be given to a general inspector of primary instruction specially appointed for the purpose. This museum will be also a central library for primary education in France.

WE have received two numbers (February and March) of the *College Journal*, issued in connection with the Georgetown (R.C.) College, U.S. The latter number contains an article resuming some of the more recent conclusions with regard to sun-spots.

WE have on our table the following books:—"Description of Vertebrate Remains," Prof. Joseph Leidy (Collins, Philadelphia); "Characeæ Americanæ," part 1 (Timothy F. Allen, New York; "Sport in British Burmah, Assam, and the Cassyah and Jyntiah Hills," Lieut.-Col. Pollok (Chapman and Hall); "Obituary Notices of Astronomers," Edwin Dunkin (Williams and Norgate); "On the Nature of Life," Ralph Richardson (H. K. Lewis); "The Gault," F. G. Hilton Price (Taylor and Francis); "Ausgestrahlte Licht," Edw. L. Nichols (E. V. Huth, Göttingen); "The Students' Text-Book of Electricity," Henry M. Noad (Crosby Lockwood); "Atlas of Histology," part 3, E. Klein and E. N. Smith (Smith, Elder); "Organic Chemistry," Hugh Clements (Blackie and Sons); "Evolutions Old and New," S. Butler (Hardwicke and Bogue); "Treatise on Natural Philosophy," vol. i. part 1, Thomson and Tait (Cambridge University Press); "Mechanics," R. S. Ball (Longmans); "Health and Occupation," B. W. Richardson (S.P.C.K.); "Electric Lighting," J. N. Shoolbred (Hardwicke and Bogue); "Hydro-Incubation," Thos. Christy (Christy and Co.); "Principles of the Algebra of Logic," Alex. Macfarlane (Douglas); "Geological Map of Northumberland," G. A. Lebour (Andrew Reid); "The Ibis" (General Index 1859–76), Ed. O. Salvin (Van Voorst); "Middleton's Impeachment of Modern Astronomy" (Judd and Co.); "Hints on the Pronunciation of the French Language," L. J. V. Gerhard (Hachette and Co.); "Analytical Chemistry," Dr. John Muter (Wm. Baxter); "Pharmaceutical Chemistry," Dr. John Muter (Wm. Baxter); "Manchester Science Lectures for the People, 1877, 1878, 1879" (John Heywood); "Australasia," A. R. Wallace (E. Stanford).

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus erythræus*) from India, presented by Mr. H. Winsor; a Vulpine Phalanger (*Phalangista vulpina*) from Australia, presented by Mr. A. Elder; a Ring-necked Parrakeet (*Palæornis torquatus*) from India, presented by Mr. F. S. Prince; a Herring Gull (*Larus argentatus*), European, presented by Mr. C. H. de Loecker; a Rough Terrapin (*Clemmys punctularia*) from Trinidad, presented by Surgeon-Major C. J. Weir; a Puma (*Felis concolor*) from America, purchased; two Squirrel Monkeys (*Saimaris sciurea*) from Guiana, two Plantain Squirrels (*Sciurus plantani*) from Java, a blue Jay (*Cyanocitta cristata*) from North America, an Ariel Toucan (*Ramphastos ariel*) from Brazil, a Sclater's Curassow (*Crax sclateri*) from South America, deposited; a Zebu (*Bos indicus*), two Geoffroy's Doves (*Peristera geoffroyi*), a Yellow-legged Herring Gull (*Larus leucophæus*), bred in the Gardens.

ON THE INFLUENCE OF PRESSURE UPON THE SPECTRA OF GASES AND VAPOURS

HERR G. CIAMICIAN has recently communicated to the Vienna Academy the results of a series of interesting experiments made with a view of investigating the influence of pressure upon the spectra of gases and vapours. From the somewhat lengthy report we gather the following data, which may prove acceptable to those of our readers who are actively engaged in spectroscopic research. The spectra of the three halogens, chlorine, bromine, and iodine, show on the whole the same peculiarities when the pressure is increased. The bright lines become diffused, sometimes a little broader, without, however, changing into bands. Besides this, a continuous illuminated background appears, which increases in brightness with the pressure, and which often overpowers the lines. This is particularly the case with iodine, where, eventually, nothing but a continuous spectrum is seen; while with chlorine and bromine certain lines yet remain brighter than the continuous light. The behaviour of certain lines in the red part of the spectra of chlorine and bromine is remarkable, as they retain their original sharpness and fineness under any pressure.

The spectrum of sulphur does not change at all under increased pressure, the lines retain their full sharpness, and a continuous bright background appears only at the red end of the spectrum. In the case of phosphorus and arsenic there is no reaction at all, as here even the continuous background does not appear. Herr Ciamician thinks that it has been overlooked hitherto that arsenic under a moderate pressure, and without a Leyden jar being inserted into the electric current, gives a spectrum of the first order, viz., a nearly continuous one, which, when the density becomes greater and the Leyden jar is inserted, disappears, and is replaced by a line spectrum.

Metals behave very differently to the non-metals just mentioned; here a real band-like extension of the spectral lines takes place, while the continuous light remains subdued. In the mercury spectrum the enlargement of the green and violet lines are specially noteworthy. In the sodium spectrum Herr Ciamician could observe the enlargement, which is very considerable, only with the *reversed, i.e.*, dark D line, as he could not observe the spectrum emitted in any other way than through a layer of sodium vapour. Under high pressure sodium gives a continuous background in the immediate neighbourhood of the D line, and upon this the reversed D line appears. At first it is seen as a double line, but soon afterwards the two lines flow into one in consequence of the enlargement; the dark band thus formed becomes wider and wider, until it finally covers the whole background which appeared in continuous light.

SCIENTIFIC SERIALS

THE *Revue Internationale des Sciences* (April, 1879) contains the following papers:—On symbiosis, by Prof. de Bary.—On the physical and intellectual evolution of woman among the different races, by M. Zaborowski.—On the chromatic function of the octopus, by Dr. L. Frédéricq.—On the source of muscular power, by A. Flint.—On the constitution of the blood plasma, by Dr. L. Frédéricq.—On the nature of lichens, by Dr. J. Müller.—On the entozoa of insects, by Osman Galeb.

THE *Verhandlungen der naturforschenden Gesellschaft zu Freiburg in Baden* (vol. vii. part 3) contains the following papers:—On a generalisation of Jacobi's reversion problem of Abel's integral, by F. Lindemann.—On the determination of the coefficient of elasticity through the bending of short rods, by K. R. Koch.—Microscopical observations on the growth and melting away of alum crystals in solutions of isomorphous substances, by F. Klocke.—On an automatic water and air-pump, by L. von Babo.—New discoveries in the Freiburg flora, by J. Schill.—On some minor actions of wind, by F. C. Henrici.

THE *Archives des Sciences physiques et naturelles* (April, 1879) contains the following papers:—Remarks on the geological review of Switzerland for 1878, by Ernst Favre.—On the *seiche* occasioned by the cyclone of February 20 last, by Prof. Ph. Plantamour.—On the hurricane of February 20, by F. A. Forel.—On the presence of tannine in vegetable cells, by J. B. Schnetzler.—On the meteorology of the Presidency of Bombay, by Ch. Chambers.—Researches on electricity, by Gaston Planté.—On the compounds derived from oxypropylbenzoic acid, by R.

Meyer and J. Rosicki.—On a new glucosid obtained from *Lupinus luteus*, by E. Schulze and J. Barbieri.—On the action of bromine upon some paraffins of high molecular weights, by V. Merz and F. Weith.—On cantharic acid, by J. Piccard.—On some reactions of silver ultramarine, by K. Heumann.—On the reactions of nitrosyl silver, by W. Zorn.—On the transformation of undecylenic acid into undecylic acid ($C_{11}H_{22}O_2$), by F. Krafft.—On the stipulæ and their *rôle* in inflorescence and the flowers of plants, by M. Clos.

SOCIETIES AND ACADEMIES

London

Royal Society, May 8.—"On the Relation between the Diurnal Range of Magnetic Declination and Horizontal Force, as observed at the Royal Observatory, Greenwich, during the years 1841 to 1877, and the Period of Solar Spot Frequency." By William Ellis, F.R.A.S., Superintendent of the Magnetical and Meteorological Department, Royal Observatory, Greenwich. Communicated by Sir George Airy, K.C.B., F.R.S., Astronomer-Royal.

In this paper the author draws attention to the long series of magnetical observations which have been made at the Royal Observatory under the direction of Sir George B. Airy, K.C.B., Astronomer-Royal, and remarks that examination of the Greenwich records shows that, in addition to the ordinary diurnal and annual changes, there appears to exist, in the magnetic diurnal ranges, an inequality, resembling in its features the well-established eleven-year sun-spot period.

This is not by any means the first time that such relation has been discussed, it being, by some investigators, considered to be already sufficiently well proved. But it appeared that the long series of Greenwich observations might be well applied as an independent test of the accuracy of the supposed relation.

The results for declination and horizontal force only are used, the strict continuity of the record by the vertical force instrument being somewhat broken.

The monthly mean diurnal range of declination, or of horizontal force, is taken to represent the magnetic energy of the month relatively to other months, and smoothed curves of the magnetic numbers and Dr. Wolf's sun-spot numbers are drawn, which show a remarkable similarity.

The epochs of minimum and maximum being tabulated, it is found that, on the average, the mean magnetic epoch follows the sun-spot epoch by 0·27 of a year. By another method of tabulation the difference becomes reduced to 0·10 of a year.

It seemed further desirable to ascertain whether the more fitful changes of the phenomena in any way also correspond. To make this comparison, the magnetic numbers, instead of being smoothed, as before described, were now cleared only of the *average* annual inequality, and compared with the *actual* monthly sun-spot numbers. Curves are given, founded on these numbers, and they show some very remarkable correspondences between the more rapid sun-spot and magnetic variations, especially between the years 1869 and 1873.

Further inquiry seems to point to a variation in the annual inequalities of magnetic diurnal range.

The following are the general conclusions supposed to be derived from the whole inquiry:—

1. That the diurnal ranges of the magnetic elements of declination and horizontal force are subject to a periodical variation, the duration of which is equal to that of the known eleven-year sun-spot period.

2. That the epochs of minimum and maximum of magnetic and sun-spot effect are nearly coincident; the magnetic epochs, on the whole, occurring somewhat later than the corresponding sun-spot epochs. The variations of duration in different periods periods appear to be similar for both phenomena.

3. That the occasional more sudden outbursts of magnetic and sun-spot energy, extending sometimes over periods of several months, appear to occur nearly simultaneously, and progress collaterally.

4. That it seems probable that the annual inequalities of magnetic diurnal range are subject also to periodical variation, being increased at the time of a sun-spot maximum, when the mean diurnal range is increased, and diminished at the time of a sun-spot minimum, when the mean diurnal range is diminished.

Conclusions Nos. 1, 2, and 3 appear to be sufficiently certain, but the evidence in favour of No. 4 is not so decisive.

Chemical Society, May 15.—Mr. Warren de la Rue, president, in the chair.—The following papers were read:—On nitrification, part ii., by R. Warington. The author finds that light hinders the conversion of ammonia salts into nitrites and nitrates, by the nitrifying ferment; the presence of carbonate of calcium is indispensable; nitrification is stopped by a temperature of 40° C.; there is a period of incubation after the addition of the ferment, during which no effect is produced; this period is increased by using stronger solutions of ammonia salts, but diminished by raising the temperature; in some cases nitrites, in others nitrates are formed.—On the alkaloids of the Veratrum family, part iii., by C. R. A. Wright and A. P. Luff. The authors have obtained two new crystalline alkaloids, pseudojervine, melting at 299°, and rubijervine, melting at 237°, and a new amorphous base veratralbine, from Veratrum album.—On the alkaloids of the Veratrums, part iv., by C. R. A. Wright. From Veratrum viride the author has obtained jervine, pseudojervine, rubijervine, veratrine, and cevadine.—On the alkaloids of the aconites, part iv., by C. R. A. Wright and A. P. Luff. The authors have examined Japanese aconite roots, and obtained a base Japaconitine melting 185°, resembling aconitine. By saponification a new base Japaconin was formed. The yield of alkaloids from Japanese aconite is about three times that from *A. napellus*.—On the action of hydrochloric acid on manganese dioxide, by S. U. Pickering. The author criticises, and in the main disagrees with the conclusions of W. W. Fisher as to the existence of manganese tetrachloride.—On some reactions of the ammoniochloride of magnesium, known as magnesia mixture, by H. D'Arcy Power. The author has observed that potassium salts, and especially potassium iodide, precipitate magnesium hydrate from this solution to an extent equal to 46 per cent. of the magnesia present.—The composition of cow's milk in health and disease, by A. Wynter Blyth. The author has separated from whey two alkaloidal bodies, by precipitation with nitrate ot mercury, galactine, and lactochrome; also a supposed glucoside, precipitated by tannin. He gives details as to the composition of milk from healthy and diseased cows, and concludes that a cow suffering from very acute disease may give milk differing in no essential feature from normal milk.—On the effect of alcohol on saliva, and on the chemistry of digestion, by W. H. Watson. Alcohol hinders markedly the conversion of starch into sugar by saliva; a trace of hydrochloric acid, on the other hand, increases the rapidity of the conversion.

Anthropological Institute, April 29.—Mr. E. Burnet Tylor, D.C.L., F.R.S., president, in the chair.—The following new Members were announced:—W. S. Duncan and Edmund Knowles Binns.—A paper was read by Col. H. Yule, C.B., entitled "Notes on Analogies between the Indo-Chinese Races and the Races of the Indian Archipelago." The author first stated that the paper was written abroad some nine or ten years ago, and had been unaltered since. A large number of analogous manners and practices were adduced, common alike to the peoples of the two regions, which Col. Yule, in conclusion, considered would singly be of no value as arguments for some original close bond of kindred between the races of the Indo-Chinese countries and those of the Archipelago. But when thus accumulated they must surely be admitted to have great weight, and to be too numerous and striking, considering the comparative contiguity of the regions occupied by those races, and the physical resemblances which often occur among those of them, the most remote from one another to be due merely to the parallel development of isolated bodies of men in like stages of growth.—A paper was also read by the Rev. James Sibree, jun., of the London Missionary Society, upon relationships and the names used for them among the peoples of Madagascar, chiefly the Hovas, together with observations upon marriage customs and morals among the Malagasy. It was remarked that in the Malagasy language there are in many classes of words strange deficiencies, as compared with English, while, at the same time, in other groups there is great fulness and minuteness of distinction. Notice was taken of the low standard of morals generally prevailing through the island, and of the evidence of this given by the dictionary, in the absence of such words as chastity, purity, and allied terms. The paper concluded by a description of the class distinctions among the Hovas, there being three main divisions: the Andrians or nobles, the Hovas or commoners, and the Andevo or slaves, the subdivisions of which were also pointed out, together with the restrictions upon marriage between the different ranks of native society.

Entomological Society, May 7.—J. W. Dunning, M.A., F.L.S., vice-president, in the chair.—M. N. Joly, of Toulouse, was elected a Foreign Member.—Mr. H. J. Elwes exhibited a collection of lepidoptera made in Asia Minor by Dr. Staudinger.—Dr. Wallace exhibited a collection of lepidoptera made by his son in the United States of Columbia.—Mr. W. L. Distant exhibited a West African specimen of the large water-bug, *Hydrocyrius Columbiæ*, Spin., common also to Madagascar and the Neotropical region; and read extracts from a letter received from Calabar district as to its power of attaching itself to stones by its tarsal claws, and even lifting large ones by the same means.—The Secretary exhibited an alcoholic specimen of a trichopterous insect belonging to the *Leptoceridæ*, forwarded from Brazil by Dr. Fritz Müller, and remarkable on account of its showing very distinctly the branchiæ lately discovered in the imago stage of this order by Dr. Palmèn.—Dr. Wallace stated that, as the result of large numbers of experiments upon the rearing of silk-moths of various species, he had come to the conclusion that the ordinary *Bombyx mori* is the only species that could be profitably reared in this country.—Sir John Lubbock forwarded for exhibition two species of *Bombycidæ* from Adelaide, South Australia, together with their cocoons, eggs, and larvæ, and a letter from Mr. G. Francis giving details of the life-history of the specimens exhibited.—Mr. McLachlan read a note received from Mr. W. J. Wilson, residing in North-west India, referring to the appearance of locust-swarms in that district.—Dr. Fritz Müller communicated a paper entitled "Notes on the Cases of some South Brazilian Trichoptera."—Mr. Wood-Mason read a paper entitled "Morphological Notes bearing on the Origin of Insects," and exhibited microscopical preparations in illustration.

Victoria (Philosophical) Institute, May 19.—After the election of several new members, a paper on the ethnology of the Pacific was read by the Rev. S. J. Whitmee, illustrated by diagrams and an ethnological map of the Pacific, which Mr. Whitmee had prepared during his long residence in many of the various groups of islands in that ocean; many present afterwards joined in the consideration of the paper, in which the author gave many reasons for believing that in earlier times a considerable intercommunication took place between the Continent and the islands, and that there was no reason for believing that, from the evidence already obtained, any arguments could be drawn against the unity of the human family.

PARIS

Academy of Sciences, May 12.—M. Daubrée in the chair.—The following papers were read:—On vision of colours, and particularly the influence exerted on vision by coloured objects moving circularly, when observed comparatively with similar objects at rest, by M. Chevreul. A third extract from his work on the subject.—On the bases derived from aldol-ammonia, by M. Wurtz.—Note relative to a communication of M. Meunier; and on similar water-spouts observed recently, by M. Faye. The accounts are cited as giving strong confirmation of his theory.—Maps of the coast of Tunis and Tripoli, by M. Mouchez. These eleven maps, covering about 250 leagues of coast, are the outcome of M. Mouchez's recent voyage in the *Castor*. The Gulf of the Greater Syrtis seems destined to be always desert, and a dread to navigators; the fanatical and hostile Nomads seem to visit its borders only to pillage wrecked vessels. The coasts of the lesser Syrtis are more hospitable under the government of Tunis. In view of the expensiveness of M. Roudaire's scheme, M. Mouchez wishes it were undertaken by others than the French. The tides are very sensible and pretty regular in the Gulf of Khabs. Unfortunately the natives destroyed the scales erected, so that the author can only give approximate figures.—On the history of the theory of the thrust outwards in slanting arches, by M. de la Gournerie.—On the transformations of the second order of hyperelliptic functions, which, applied twice successively, produce duplication, by M. Borchardt.—M. Oppolzer was elected Correspondent in Astronomy in room of the late M. Argelander, and M. Favre Correspondent in Mineralogy in room of the late M. Leymerie.—On the effects of inhalation of spirit of turpentine, by M. Poincaré. His observations were both on workmen and animals. The disorders produced in the former are headache, giddiness, irritability, pricking and tearfulness in the eyes, and weakness of sight, irritations of pharynx and larynx, vomiting, &c. Through habit, men get to bear the vapours longer. The troubles are more intense and constant with spirits of turpentine from Hungary and America than with those of French origin. Animals which died from the acute poisoning in confined space generally showed congestion and free drops of the condensed spirit in the blood.—On the means used by M. Gyldén for regulating trigonometric developments representing perturbations, by M. Callandreau.—On a new form of co-ordinates in the problem of two bodies, by M. Gyldén.—On two applications of the method of MM. Fizeau and Foucault. These rest (1) on substitution of a known system (in which the distance of the lines is determined by the condition that the wave-length of D is 0·0005888), and (2) on the use of formulæ of dispersion. The first application is the measurement of the thickness of a parallel crystalline plate; the second, study of the dispersion of double refraction of a plate.—Thermal researches on silicic ether, by M. Ogier. Its heat of formation may be determined either by analysis or by synthesis. The one method gave − 11·56 cal., the other − 11·44 cal.; mean − 11·5 cal. The heat of vaporisation of silicic ether is, for 1 equivalent, 7·0 cal.—Action of ammoniacal salts on some metallic sulphides, and application of the facts observed to mineral analysis, by M. De Clermont.—On a new mode of formation of glycocol by means of nitracetic ether, by M. De Forcrand.—On the production of conidia by a bacillus, by M. Engel. This was observed in June, 1876, when some of the numerous bacilli in the blood of a woman who had died in childbed were placed in Pasteur's nutritive liquor. M. Engel designated the bacillus as *puerperalis*.—Influence of heat on the functions of the nervous centres of the crayfish, by M. Richet. Either by asphyxia, or (better) by temperatures varying from 23° to 36°, one may paralyse separately the different functions of the ganglionic nerve centres; the voluntary, intellectual innervation disappears first at 23° to 26°; the reflex innervation, properly so-called, disappears at 27° to 29°; and lastly, the innervation of respiration disappears at 28° to 30°.—Regeneration of nerves of the anterior epithelium of the cornea, and theory of continuous development of the nervous system, by M. Ranvier. The regeneration of cells of the anterior corneal epithelium precedes that of the nerves, showing that the reproduction and nutrition of the epithelial covering of the cornea are independent of the nervous system. The last nervous ramifications tend by their nature to grow continually at the periphery.—On the respiratory apparatus of Ampullaria, by M. Jourdain.—On a new genus of Anouran Batrachian of Europe, by M. Lataste. This has been observed in Spain by M. Bosca. M. Lataste gives it the name *Ammoryctis*; it takes rank in the family of *Alytidæ*, of the sub-order of *Mediogyrinides*.—On the peculiar amyloid matter in the asci of some Pyrenomycetes, by M. Crié.—On the discovery of a jaw of Cainotherium in the gypsums of Aix (Bouches du-Rhone), by M. Cairol. On borings made in view of formation of an interior sea in Algiers, by M. Roudaire. The new results are of the same order as the former.—Water-spouts at Vitry-sur-Seine, by M. Meunier.—M. Hervé Mangon presented the first volume of a "Statistical Atlas of Water-Courses, Manufactories, and Irrigations of France;" also a work by M. Demontzey, on the works of replanting and returfing mountains.

CONTENTS

THURSDAY, MAY 29, 1879

HOW TO LEARN A LANGUAGE

How to Learn Danish (Dano-Norwegian). By E. C. Otté. (London: Trübner and Co., 1879.)

THE tourists who now crowd into Norway summer after summer are apt to find that a better acquaintance with the language of the country is required from them than is the case in the more frequented parts of Europe. They ought, therefore, to be grateful to Miss Otté for having provided them with an excellent manual for acquiring the necessary knowledge, since Danish is the language not only of Denmark but of the towns of Norway also, though more or less varying dialects are spoken by the peasants in the isolated dales. The manual is composed according to the Ollendorffian method; but a systematic grammar and rules for pronunciation are appended at the end, and the whole book is prefaced by an interesting and instructive introduction.

The Appendix corrects the chief defect of the method of teaching foreign languages initiated by Ollendorff. This is its neglect to pay proper attention to so very important a matter as pronunciation and phonetics. Ollendorff seems always to presuppose the presence of a teacher who is either a native or else thoroughly acquainted with the phonetic peculiarities of the language he teaches. No doubt in learning a foreign tongue it is advisable to have such a teacher close at hand; but sometimes this is not possible, and the possibility is admitted by Ollendorff himself when he claims that his method will enable the pupil to dispense with a teacher altogether. It is clear, however, that Miss Otté, though she comes to the rescue of the student in regard to the pronunciation of Danish, has never paid very close attention to phonetics. The learner who tried to speak Danish in accordance with the rules of pronunciation she has laid down for him, would speak it with a very Anglicised accent indeed. Not a word is said even of that marked characteristic of Danish, the "stödtone" or glottal catch. For Danish pronunciation, it is desirable to consult Mr. Sweet's article in the *Transactions* of the Philological Society, 1873-4.

The very fact that so integral a part of language as phonology should be thus passed over in works intended to promote a conversational knowledge of foreign idioms shows the unsatisfactory character of our present mode of teaching languages, even at its best. It is based rather on empirical haphazard than on scientific principles. The method and results of comparative philology have as yet had but little influence on practical education. It is the old story of the divorce between the man of science and the man of practice, and, as usual, education suffers. If we would know how languages ought to be learned and studied we must give heed to the lessons of science which are also the lessons of nature.

Language consists of sounds, not of letters, and until this fact is thoroughly impressed upon the mind, it is useless to expect that languages will ever be studied aright. Language, moreover, is formed and moulded by the unconscious action of the community as a whole, and like the life of the community is in a constant state of change and development. Consequently we cannot compress the grammar of a language into a series of rigid rules, which, once laid down by the grammarian, are as unalterable as the laws of the Medes and Persians. On the contrary, grammar is what the community makes it; what was in vogue yesterday is forgotten to-day, what is right to-day will be wrong to-morrow. But above all, language, except for the purposes of the lexicographer, consists not of words but of sentences. We shall never be able to speak a foreign tongue by simply committing to memory long lists of isolated words. Even if we further know all the rules of the grammarians, we shall find ourselves unable in actual practice to get very far in stringing our words together or in understanding what is said to us in return. This was not the way in which we learnt our own mother-tongue, and if we would learn another language easily and correctly we must set about learning it as we learnt our own.

Ollendorff had the merit of seizing hold of this important fact, and to this his system owes the success it has obtained. Let the pupil first saturate his mind, as it were, with sentences or phrases; there will be plenty of time afterwards to analyse these into words and grammatical forms. We must begin with the whole, not with its parts; analysis is the task of science, not of practical education. But in both alike we must start with the known, or the best known; the unknown or less known to which we work back will differ according as our object is a scientific or a practical one.

If our object is the practical one of acquiring languages the less known will be those idioms which present special difficulties either through the strangeness and unfamiliarity of their structure and modes of expressing thought, or still more through their being now extinct. To learn a dead language in anything like a proper way is a very hard matter. We must first be able to think in other languages than our own and know what language really is; in other words, we must have a sound acquaintance with living tongues. Until we can realise that Greek and Latin are in no essential respect different from English, or French, or German, that they do not consist in a certain number of forms and rules learned by rote out of a school-grammar, or even in the polished phrases of a few literary men, but in sounds once uttered and inspired with meaning by men who spoke and thought as we do, the long years spent over Latin and Greek are as good as wasted. It were far better to fill our minds and store our memories with something which will be practically useful to us in after life and at the same time afford that mental training of which we hear so much. To begin our education with the dead tongues and afterwards fill up the odd intervals of time with a modern language or two is to reverse the order of science and nature. The necessary result is to produce a total misapprehension of the real character of speech, a permanent inability to gain a conversational knowledge of foreign idioms, and a false and generally meagre acquaintance with the classical languages themselves. It is not wonderful that the small modicum of Latin and Greek acquired during years of painful work at school should so frequently disappear altogether as soon as school is left, and considering the erroneous views this small modicum of learning implies it is perhaps hardly to be regretted that it should.

When a conversational knowledge of a foreign idiom

has once been obtained and the pupil is able to think in another language than his own, the analysis and study of the idiom should be carried on in the light of comparative philology. He should be taught to see that the apparently arbitrary phenomena of language are all subject to strict law, and that the forms and words he uses all have a history and a reason for being what they are. In this way his intelligence as well as his memory will be excited and quickened, his curiosity, that "fountain-head of science," will be legitimately aroused and satisfied, and above all the conception of law will be made familiar to him from the first beginning of his education. When the action of philological laws has been traced and illustrated in modern languages, it will be easy to pass on to the dead ones and show how they are but the earlier forms of living speech, past links in the great chain of unbroken development.

Before parting from Miss Otté, allusion must be made to the reformed spelling of Dano-Norwegian and Swedish, which she has adopted in her Manual, and of which she has given an interesting account in her Introduction. This reformed spelling is in the first instance due to Rask, the great Danish philologist, but it owes its present acceptance to the Stockholm Conference, called together in 1869 by the exertions of Prof. Daa, and to the Dano-Norwegian dictionary which was the result of it. The vicious spelling of the past has now been superseded by a consistent and fairly phonetic one, based upon a scientific alphabet. In this respect the Danes have set us an example which it would be well to follow. The "practical men" of Scandinavia have at last condescended to listen to the recommendations of those who study language scientifically, and the people consequently now possess an orthography which forms no hindrance to learning to read and write and throws no veil over the true nature of speech. Let the Englishman who uses Miss Otté's Manual try to put himself in the place of a Dane who wishes to learn English, and then consider whether he does all in his power to facilitate the acquisition of at all events one language by the foreigner.

A. H. SAYCE

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Spectrum of Brorsen's Comet

I AM much obliged to Mr. Christie for his answer to my question. There can remain no doubt that Brorsen's comet does not *now* give the same spectrum as, according to Huggins's observations, it did in 1868. The difference in position between the brightest lines in the two spectra of carbon is, it is true, very small, but if it were possible it would be a step gained to decide which of the two lines the brightest comet band coincides with, 5198·4 or 5165·5, since as far as experimental evidence goes at present one of these lines is due to carbon-vapour and the other to an oxide of carbon. I fear that Prof. Piazzi Symth's theory that the spectrum in question is caused by hydrocarbon must be rejected for experimental reasons which I will presently recapitulate. I have had no experience in comet-spectroscopy, not having access to any telescope of sufficient aperture, and I do not wish, therefore, to seem to make light of the achievement of Mr. Christie and Prof. Young; but if it were possible to adjust the occulting bar so as to *completely* hide (but only *just* hide) the least refrangible edge of the brightest comet-band, then I should imagine that, on flashing in the spectrum of the alcohol-tube, its band would be seen beyond the bar if the comet-spectrum be, as is most probable, that which I have called "Carbon No. I."

At present the observations at the Royal Observatory seem to point to a coincidence with the second spectrum, but it was the *first* which Prof. Young employed and which Prof. Huggins also employed. A reference to Prof. Huggins's account of his experiments shows that the comparison-spectrum was obtained by taking the electric spark in olefiant gas at the ordinary pressure; and he further observes (*Quart. Jour. Science*, April, 1869) that "the same spectrum is given by the spark in cyanogen."

The difference between the spark in olefiant gas and in olive oil, shown in Huggins's diagram, is simply one of detail—the separate lines being distinctly seen in the spectrum of the oil and not in that of the gas.

Prof. Piazzi Smyth's alcohol-tube seems to differ from Mr. Christie's in containing besides the lines of spectrum No. II. (if he will allow me to call it so) the green band seen in the blue base of a candle flame—that is the band beginning with 5165·5.

This, I believe, is always the case if the vapour be at a somewhat high pressure. A reference to the *Phil. Trans.* for 1865, or the *Phil. Mag.* for October, 1869, will show that the tubes with which Plücker worked contained lines of both spectra—and that he did not succeed in completely separating the two. But a tube containing pure carbonic oxide at a small pressure (one or two millimetres) shows no trace of this green band even "end-on."

I cannot accept Prof. Piazzi Smyth's theory that this green band and the remainder of the lines in spectrum No. I. are due to hydrocarbon, for the simple reason that they are obtained brilliantly from substances which do not contain hydrogen, viz., cyanogen, carbonic oxide, and sulphide of carbon.

There is no more magnificent spectrum than the "carbon spectrum No. I.," obtained by burning cyanogen and oxygen together at the nozzle of an oxyhydrogen blow-pipe.

I should like to refer Prof. Smyth for other arguments than my own and for experimental evidence to a paper to be found in the *Ann. Ch. Phys.* for 1865, t. 4, p. 305.

Giggleswick, May 27 WILLIAM MARSHALL WATTS

A Universal Catalogue

THE last April number of NATURE contains an article on a Universal Catalogue, which seems to be still under discussion.

So great a work, when undertaken, should to a certain extent be complete, so as not to necessitate the same thing having to be done fifty times. With a really universal catalogue of books and memoirs existing, it would be quite easy for each library to form its own catalogue in a much abbreviated form. For instance:—

Brewster, Optics. 1831. P. 2350, or

Hauy, Crist. et Propr. phys. Enclase. 1819. Min. 6430,

would be quite sufficient to stand for—

Brewster, Treatise on Optics. London, 1831. Catalogue of Physical Science Papers, 2350. and

Hauy, Mémoire sur la Cristallisation et sur les Propriétés physiques de l'Enclase, Paris, Mus. Hist. Nat. Mém. v. 1819, pp. 278-293. Catalogue of Mineralogical Papers, 6430.

So in the library catalogues no cross references and main titles would be necessary, and no double and treble lines for titles of books or memoirs, five or six words and two numbers being sufficient to characterise each publication, while now, there being no general catalogue, each library desiring to give its catalogue—an undertaking which is highly desirable—is obliged to spend disproportionate cost, time, and space for such a purpose.

But scientific workmen would also be much better served in this way, as may be shown by the following facts:—

Putting the whole number of titles in the British Museum catalogue at 3,750,000 (1,250,000 real ones, 2,500,000 cross references, &c.), they may be classed into old and modern works, the former 750,000, the latter 3,000,000. Now, putting the number of special branches which deserve and imperatively demand special catalogues of subjects—as mathematics, botany, statistics, &c., &c.—at 50, and supposing that old books extend even 15 to 20 branches each, every special branch is represented by $\frac{760000}{60} \cdot 20 = 300{,}000$ titles of old publications and $\frac{3000000}{60} =$ 60,000 of new ones.

So, one seeking for books of a single branch does not find

more than 360,000 titles among 3,750,000, filling, when printed alone, 4·32, or in round numbers, 5 volumes of the 45, while he must undergo the trouble of using all the 45, or of this work, $\frac{40}{45}$, *i.e.*, 89 per cent. is useless and annoying for him, and $\frac{5}{45}$, or 11 per cent. only is useful; the space needed for the catalogue is about 4 metres, 44 centimetres of which are useful, and 3m. 56cm. disturbing; and, last but not least, he pays 36*l.* instead of 4*l.*

But with all this superfluous work, still no complete catalogue is acquired, but a very deficient one; for of periodical journal articles there are about 3,000,000, separate works about 6,000,000 in a rough estimation, or together, 9,000,000, *i.e.* (no main titles or cross-references being herein comprised), about six times the number possessed by the British Museum library.

Supposing, in the same proportion as above, these 9 millions of publications to be accompanied by 12 millions of main titles, &c.; supposing, then, these 21 millions of entries to be composed of 4·2 millions of old and 16·8 millions of new ones, the publication of these could be effected as follows:—

The titles of old books, being used much seldomer than new ones, and belonging mostly to fifteen to twenty different branches, could form a special catalogue of fifty volumes, whose price would be 40*l.*; each great city might content itself with a single copy accessible to all men of science.

The remaining 16·8 millions of modern publication titles, divided into fifty branches, would give 360,000 entries for each of them, or *five volumes for 4l.*, so that even private libraries would be enabled to possess a complete catalogue of all modern publications of a single branch.

As to the construction of such catalogues, the following would perhaps be a practical method:—

At first a committee for the defining of branches and the limit between old and modern publications should be appointed, to which all greater libraries should send copies of their catalogue classifications; by means of these copies exact rules for the extent of branches and the method of working could be drawn up in six months.

This work done, a numerous catalogue committee should be formed, to which all greater library catalogues should be sent in copies; where such copies are wanting the library should be examined by members of the committee, using the thitherto ready part of the catalogues.

The periodical publications before 1800 and after 1873, should be registered in the same manner as those in the "Royal Society Catalogue," and then subdivided into single branches by the committee. In this way complete catalogues for great groups could be formed, care being taken not to restrict the limits of these too much in order to hasten the publication of the work. This publication would be the first and hardest step to a manageable index of literature.

During the next ten years after its publication the completion could be carried out by putting beside each title a short classification of its contents, not an extract—contained in a single word or phrase, like "electrostat." or "relat. age mortal.," for "electrostatics" or "relation between age and mortality," or a few single words when different matters are treated; these classifications, made simultaneously by different persons and compared, together with all corrections, could be printed about twelve years after the first catalogue, and form the final work, which at short intervals of five or ten years should be completed by appendices.

ARISTIDES BREZINA

Custos of the Imperial Mineralogical Museum, Vienna

Distribution of Mus rattus

I AM able to-day to complete my note in NATURE, vol. xx. p. 29, as to the exact habitat of the black rat in Thuringia. Prof. Liebe, of Gera, kindly wrote to me that it occurs in East Thuringia and the Voigtland in single elevated side-valleys of the rivers Weisse Elster and Roda, as well as in single lurking-places of the Frankenwald. Here it occurs in isolated forest-houses, in the valleys, in whole partly large villages, for instance, St. Gangloff. In this place for a long time past *Mus rattus* and *M. decumanus* have occurred together among each other, not one above the other, on different floors, as might be supposed, though *rattus* now and then rather prefers the upper floors, and the latter does not appear to be decreasing in number. In those villages about three specimens of *rattus* are always killed for one specimen of *decumanus*, the latter, apparently, being less numerous.

A. B. MEYER

Dresden, Royal Zoological Museum, May 20

Insect Galls Buds

I WAS much interested in Mr. A. Stephen Wilson's letter upon this subject (NATURE, vol. xx. p. 55). I must, however, demur to his statement that "all insect-galls are in reality leaf-buds or fruit-buds," as too sweeping to be accurate. I can hardly include in the above category the numerous galls which make their appearance on the growing leaves of trees, such, for example, as the oak-spangles (of *Neuroterus malpighii*) or the galls of the *Spathegaster baccarum*, *Andricus curvator*, &c., several of which may be placed on the veins of a single leaf. These examples cannot assuredly be classed as pathologically developed leaf or fruit *buds* only so far as woody growth usually takes place through buds. In a short paper I once read at the Linnean Society, an abstract of which appeared in NATURE during the early part of the year 1875, I drew attention to the fact that the growth of galls took place coincidently with the growth of the tissues in which they were placed; thus the development of the bud-galls of *Cynips kolleri*, *Teras terminalis*, and *Aphilothrix gemmæ*, is to be seen in the spring, summer, and early autumn, but not in winter time when the tree growth is arrested. My observations at that time led me to suppose that the currant galls of the oak and others of the same class only grow during the growth of the leaf to which they were attached.

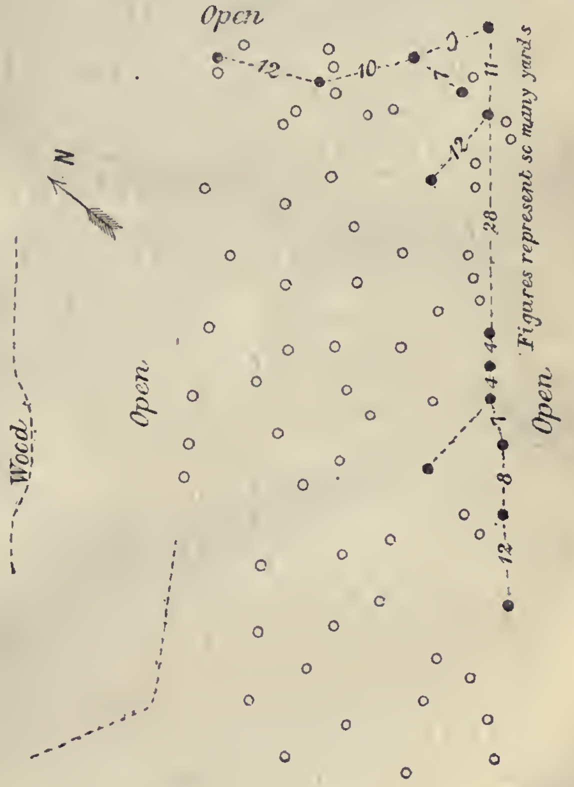
I trust Mr. Wilson will give your readers the benefit of his further researches on this subject.

W. AINSLIE HOLLIS

Brighton, May 16

Effects of Lightning

A REMARKABLE electric discharge occurred on Sir Robert Gordon's estate of Letterfourie in a small wood about four miles to the south-east of this place on November 16 last about 12.45 A.M. The accompanying sketch (scale $\frac{1}{24}''$ = one yard), where



the trees (common fir and larch) *struck* are represented by black dots, will give you an idea. The soil and trees were slightly covered with snow, which had been falling at intervals since sunset on the 15th. On that night I observed two or three flashes of lightning accompanied by thunder, and a few days afterwards

I was told by a local medical gentleman, who had visited the spot, that some eleven or twelve trees had been struck among the hills under peculiar circumstances. The snow was lying so deep at the time that the place was well nigh inaccessible, and owing to want of leisure and the continued severe weather, I had no opportunity of visiting the wood in question until a few days ago. I then ascertained from a farmer living 150 yards south-east of the spot, that the trees must have been struck simultaneously.

Between 9 and 10 P.M. on the 15th a flash of lightning, followed by loud thunder, was seen by him in the north and clear of the wood altogether; besides, the interval between flash and peal showed it to be at a comparatively great distance. The man, being an invalid, never slept, when about 12.45 A.M. on the 16th a blinding light immediately followed by a tremendous thunder-clap made him think his own house was struck. The next and last flash and peal occurred a quarter of an hour afterwards at a considerable distance away to the west.

The effect of the lightning on the trees was observed from the window on the following morning, and as the spot was daily visited by the inmates of the house for the purpose of drying clothes, there could be no doubt but the damage had been done during the previous night. All the fourteen trees, varying from six to nine inches in diameter, and not visibly higher than the immediately adjoining ones have lost the bark over a width of one half to one inch, and the wood is slightly split.

Buckie, Banff, N.B., May 12 G. W. CAMPHUIS

Intellect in Brutes

IN connection with recent correspondence in your columns, it has occurred to me that the following remarkable instance of reasoning in an animal might be of interest to your readers.

In 1877 I was absent from Madras for two months, and left in my quarters three cats, one of which, an English *tabby*, was a very gentle and affectionate creature. During my absence the quarters were occupied by two young gentlemen, who delighted in teasing and frightening the cats. About a week before my return, the English cat had kittens, which she carefully concealed behind book-shelves in the library. On the morning of my return I saw the cat, and petted her as usual, and then left the house for about an hour. On returning to dress I found that the kittens were located in a corner of my dressing-room, where previous broods had been deposited and nursed. On questioning the servant as to how they came there, he at once replied, "Sir, the old cat taking one, one in mouth brought them here." In other words, the mother had carried them one by one in her mouth from the library to the dressing-room, where they lay quite exposed. I do not think that I have heard of a more remarkable instance of reasoning and affectionate confidence in an animal, and I need hardly say that the latter manifestation gave me very great pleasure. The train of reasoning seems to have been as follows: "Now that my master has returned there is no risk of the kittens being injured by the two young savages in the house, so I will take them out for my protector to see and admire, and keep them in the corner in which all my former pets have been nursed in safety." G. BIDIE

Government Central Museum, Madras, May 3

GEOGRAPHICAL NOTES

THE anniversary meeting of the Royal Geographical Society was held on Monday last, Sir Rutherford Alcock, vice-president, in the chair. From the Council report it appears that there is no diminution in the number of Fellows, notwithstanding the losses from various causes. From a financial point of view, the Society continues to prosper, its assets being set down at over 37,000*l*., exclusive of its valuable map collection and library, both of which have received large accessions during the past year. It will be interesting to practical geographers to learn that considerable progress has been made with the revision of the classified register of maps and the preparation of an alphabetical catalogue of all the maps in the Society's collection and publications, and especially that the new catalogue is being prepared with a view to its being subsequently printed. We are also informed that a case containing a set of traveller's instruments, such as the Society recommend, has been placed in the map-room. At the conclusion of the report the royal medals were presented to Count Schouvaloff, the Russian ambassador (for Col. Prejevalsky), and General Sir Lintorn Simmons, R.E., G.C.B. (for Capt. W. J. Gill, R.E.), after which came the presentation of the Public Schools' Prize Medals, the award of which we have already recorded, and some interesting remarks on the teaching of geography, by the Rev. G. Butler, head-master of Liverpool College. The Hon. G. C. Brodrick announced the subject for next year's examination would be "Western Africa, from the Sahara to the Congo, and as far eastwards as Nyangwé." The Earl of Northbrook was elected president, and among the new members of council are General R. Strachey and General Sir H. L. Thuillier, late head of the great Trigonometrical Survey of India, both of whom are well known as scientific geographers. The Society being without a president, the annual address on the progress of geography was delivered by Mr. Clements R. Markham, the senior secretary. The chief items of news are that Lieut. R. C. Temple, of the 1st Gurkhas, has constructed a map of a large tract of previously unknown country between Candahar and Dehra Ghazi Khan, and has promised to furnish an account of the region, and that Mr. Whitely is about to attempt an examination of the mysterious Mount Roraima and its neighbourhood, in the interior of Guiana. In conclusion, Mr. Markham called attention to the short-comings of the Admiralty in the surveying department, expressing a hope that they might be induced to send out a properly equipped surveying-vessel to the southern part of the east and west coasts of Africa, "which have not been sounded since the days of Capt. Owen, half a century ago."

M. SOLEILLET, who recently tried to reach Timbuctoo, has arrived in Paris, and gave, on Monday, an address before the Société d'Études Maritimes et Coloniales, in the large hall of the Société d'Encouragement. M. Soleillet is in very good health, and no trace of his illness is now visible. He speaks highly of the negro population and the Sultan of Segou, where he spent more than three months as peaceably as in any French town, without any other escort than a single servant, a sergeant of the Senegal Rifles. The Niger at Segou-Sokkhora, more than 2,000 miles from its mouth, is about 300 yards wide. The access is very easy for traders. M. Soleillet will devote his future exploration to the determination of the best track for the trans-Saharan railway. He contrasted the good will of the negro population for the French with the hostility exhibited towards Europeans in the Sahara.

FROM *Globus* we learn that the long sojourn of the Russian troops in Bulgaria and Rumelia has been fruitful of results to geographical knowledge. The Russian staff have been active in carrying out a series of astronomical and geodetic observations, so that a fairly complete network of triangulation has been accomplished, which will enable cartographers to lay down with fair accuracy a very considerable number of places in our maps. Something like 1,000 points have been thus taken, most of them geodetically, but a considerable number astronomically. The chief results are expected to be published by 1880.

THE steamer *Nordenskjöld*, Capt. H. Sengstacke, formerly chief officer of the *Germania* on the second German Arctic expedition, sailed from Malmö, under the Russian flag, on May 12, for Behring Strait, *viâ* the Suez Canal. On board are Prof. Grigorieff of St. Petersburg, and Baron von Danckelman of Leipsic, to whom are intrusted the duties of zoologist and physicist respectively. The object in view, as our readers know, is to visit the mouth of the Lena, and, if necessary, render assistance to Prof. Nordenskjöld. The expedition is not

over-manned, as it consists but of sixteen persons, including officers, *savants*, two engineers, and three stokers. It is possible that by this time Nordenskjöld may have broken out of the ice and be on his way home by the Suez Canal. The letters received from him, referred to last week, are, Mr. Oscar Dickson informs us, dated February 8.

LETTERS from Prejevalsky, dated from Zaisan, March 20, inform us that the deep snows which cover the steppes had detained him there much longer than he had calculated. He was, however, to leave on March 21, and expected to reach Khami at the end of May, by way of the River Urunga and the southern spurs of the Altaï; unless prevented by excessive heat and want of water, he was to pursue his journey to the town of Shachjeou. Then he would attempt to ascend the two plateaux of Tibet; after ascending the second plateau he would have 1,000 versts of desert to make before reaching Lassa, from which he hopes to visit South-east Tibet.

A COMPLETE history of all North Polar Expeditions from the remotest ages down to the present day is about to be published by Cotta of Stuttgart. The title will be "Im ewigen Eis," the author is the popular writer, Herr Friedrich von Hellwald. Numerous illustrations, maps, and plans will enhance the value of the work, which will appear in thirty parts. The well-known explorer, Julius Payer, one of the commanders of the Austrian Polar Expedition in 1874, has accepted the dedication of the work.

FROM the *Colonies and India* we learn that a private telegram from Aden conveys intelligence of the arrival there on the 15th inst. of the British India Steam Navigation Company's steamer *Chinsura*, from Bombay, *en route* for Zanzibar, having on board four Indian elephants, the property of the King of the Belgians. These elephants will be employed for the purpose of ascertaining whether such animals can be made a means of transport in Africa.

THE Inter-Oceanic Canal Congress has been diligently carrying on its work in Paris for the last fortnight. It was divided into several sections, each to consider a special department of the subject. On Monday the Technical Section of the Congress met to hear reports from its two sub-committees, the second of which admitted the possibility of constructing a canal with locks by way of Nicaragua, while for a level canal it considered the course proposed by Lieutenants Wyse and Reclus to be the best, subject, however, to certain modifications. The first sub-committee presented estimates of the probable cost of the various routes.

OUR ASTRONOMICAL COLUMN

THE TOTAL SOLAR ECLIPSE OF MAY 22, 1724.—In the *Illustrated London News* of Saturday last are some quaint extracts from the newspapers of the time, relating to this eclipse, the last that was total in England. It may not be without interest to examine the general circumstances of this phenomenon, which we are now enabled to do with much precision, by taking advantage of the data furnished in Prof. Newcomb's recently published "Researches on the Motion of the Moon." The elements are as follow:—

G.M.T. of Conjunction in R.A., 1724, May 22, at 5h. 26m. 33s.

	°	′	″
Right Ascension	59	32	12·8
Moon's hourly motion in R.A.		38	21·1
Sun's " "		2	30·4
Moon's declination	21	5	7·4 N.
Sun's "	20	31	28·9 N.
Moon's hourly motion in declination ...		10	53·3 N.
Sun's " " " ...		0	29·0 N.
Moon's horizontal parallax		60	44·5
Sun's " "			8·7
Moon's true semi-diameter		16	33·1
Sun's " "		15	47·4

The sidereal time at Greenwich mean noon on May 22 was 4h. 1m. 3·6s., and the equation of time at conjunction in R.A. was 3m. 49·1s. additive to mean time.

Hence it appears that the central eclipse began at 3h. 41·6m. in long. 151° 39′ W., lat. 13° 55′ N.; it occurred with the sun on the meridian in long. 82° 36′ W., lat. 54° 30′ N., and ended in long. 11° 57′ E., lat. 45° 28′ N., or the sun set centrally eclipsed near Padua.

It was therefore late in the afternoon with the sun at small altitude that the eclipse was witnessed in these islands, and the following figures must very nearly define the course actually pursued by the moon's shadow:—

LONGITUDE.	N. Limit.	LATITUDE. Central Line.	S. Limit.
	° ′	° ′	° ′
4° W.	52 37	51 29·9	50 24
2° W.	51 57	50 49·5	49 43
0°	51 15	50 7·6	49 1
2° E.	50 32	49 24·4	48 18

The popular interest excited in this eclipse we may infer was mainly due to the publication of a chart of its track by Halley, then Astronomer-Royal. A copy of this chart is preserved at the apartments of the Royal Astronomical Society; it is entitled "A Description of the Passage of the Shadow of the Moon over Europe, as it may be expected May 11, 1724, in the Evening, by Edm. Halley, Ast. Reg." It was "Engraved and Sold by John Senex at the Globe against St. Dunstan's Church in Fleetstreet, Price 1*s*." Halley concludes some foot-notes as follows:—"At London we compute y^e^ Beginning at 5h. 40m. P.M., y^e^ Middle, when it will be nearly Total at 6.37, and y^e^ End 7.29. We wish our Astronomical Friends a clear Sky."

It will be borne in mind that the old style was still in use in this country in 1724, and the eclipse was thus dated May 11. Halley's predicted track is in very close accordance with that we have obtained above. His chart shows the central eclipse passing just south of Wexford, north of Bridgwater, over the Isle of Wight and south of Dieppe to near Venice; his northern limit of total phase passes just south of Dublin, over Leominster and Oxford, and Brentford near London, by Cambray and just north of Strasburg; the southern limit passes a little south of Kinsale, Padstow, Chartres, &c.

Dr. Stukeley observed the eclipse from Haradon Hill, near Amesbury, Wilts, and the account of it which he published in his *Itinerarium Curiosum* has been frequently transferred to our popular works. Assuming his position to have been in about 1° 47′ west of Greenwich, with a latitude of 51° 11′, we find by the above elements that totality would commence at 6h. 26m. 0s. local mean time, and continue 2m. 34s., the sun being at an altitude of 12°. The eclipse was central at or close to Ventnor, and was total there for 2m. 47s.; the newspaper of the time says, more than 1½ minute. Observations were made by Delisle and others at the Observatory of Paris, and by Maraldi and Cassini, at the Trianon, Versailles, "en presence du Roy." The calculated duration of totality at Paris is 2m. 23s., the middle at 6h. 49m. 41s. apparent time; Gaudin observed the duration 2m. 22s., and the middle at 6h. 50m. 2s.; other observers made the duration twenty seconds longer, which is certainly an error; at the Trianon it was observed to be 2m. 16s., a little less than the calculation makes it. The original observations of the French astronomers are given at p. 129 of Prof. Newcomb's work.

The next total eclipse of the sun visible in England will take place early on the morning of June 29, 1927, but totality will only continue some ten seconds.

THE MIGRATION OF BIRDS

IN a reply of Dr. Weismann's to some remarks by Prof. A. Newton in his paper on the migration of birds (NATURE, vol. xix. p. 579), a statement of mine is

quoted to the effect that "in July young starlings pass over Heligoland by hundreds of thousands *without a single old bird* accompanying them," the learned Doctor adding that he "cannot regard this as a *fact*, but as a more or less probable *conjecture*." This is a rather bold and unceremonious assertion. As, however, Dr. Weismann, with reference to the above, and to the autumnal passage of young birds prior to their parents in general, puts the question "*but are these really facts?*" admitting that if they were they would "seem to be against the sufficiency of the five senses"—and as in any probable future efforts of the learned gentleman's on the above topic, incontestable *facts* might prove infinitely more useful than ever so voluminous an amount of nicest *conjecture*, I beg to be allowed to contribute some statements bearing on the question, which are based on daily observations of mine now extending over a period of more than forty years, and made on Heligoland—than which an observatory more favoured for such purposes the rest of Europe may not afford.

Personal experience the learned Doctor does not seem to command respecting the migratory movements of birds, otherwise it might be supposed that he would have brought forward the results of his observations either in refutation of mine, or in confirmation of the same, and I cannot help adding that in my humble opinion, the treatment in whatever form of so grand and mysterious a phenomenon as the migration of birds, should be preceded by a study of the same in nature, if only it were in its simplest outward appearances. Such a proceeding would prevent the continual repetition of certain traditional errors, and of the building thereon of fallacious inferences and hypothetical assumptions.

But to return to the starlings in question. The learned Doctor maintains that I "could not possibly have inspected a hundredth part of these 'hundreds of thousands' of starlings flying about." Now, to a Heligolander, such a view of the question would, if anything, be most amusing. I fully uphold what I stated: all these birds touching Heligoland *are* inspected, and I may add that such is done by the most competent judges, who, in fact, think very lightly of distinguishing a young starling passing overhead from an old one.

When, in my correspondence with Prof. Newton, I drew his attention to the fact of the autumnal movement of young birds taking place from one to two months prior to that of their parents, I purposely referred to a species affording the most easy means for observations corroborative of my views, viz., the common starling. This bird is one of the very few species which perform their migratory flights at so moderate an altitude as to permit of the most satisfactory scrutiny of each individual of a whole flock. Besides such a scrutiny is greatly facilitated by the different colour of the old and young birds at the season in question; the former, on the wing or on the ground, appearing at any distance perfectly black, whilst the latter are of a very light brownish-grey colour, verging underneath on a soiled white; the entire appearance of both differing to such an extent that if a flight of these birds were passing overhead at a height from fifty to three hundred feet, consisting of even a thousand individuals, it would require but the most cursory glance forthwith to detect a single old bird among the whole number. That such appears so very incredible to Dr. Weismann only proves how very little practice he can have had in these matters.

Moreover, a very great proportion of these young starlings alight for some hours on the upper plateau of the rock, and furnishing, in contradistinction to the old tough birds, a rather dainty dish, they are pursued by the Heligolanders very eagerly, and shot in great numbers; the island taxidermist, Aeukeus, for instance, succeeding last summer in bagging *eighty-three* such young birds at the discharge of his two barrels. This latter incident alone may prove what quantities of these birds are captured here during the month of July of each succeeding year, and I repeat, they never contain the slightest admixture of old black specimens.

The above I suppose will be admitted as sufficiently *demonstrative facts*, and will I trust exculpate me from "building far-reaching theoretical inferences," a proceeding against which the learned doctor gravely says we must guard. May I be permitted to ask: to *whom* is this warning given? for hitherto I was rather given to believe that conjectures, theoretical inferences, and the like generally grow much more luxuriantly beneath the limited light of the study-lamp than in the face of free matter-of-fact nature.

Here may follow a few data respecting the periods of passage of the old and young starlings as noted down from daily observations, and I leave it to Dr. Weismann to admit the same as the documentary evidence of an "excellent ornithologist," as he so courteously terms me, or perhaps to dismiss them as of undemonstrated validity.

Sturnus vulgaris.—First week in June, 1878, some solitary old birds of extremely abraded plumage—supposed to be individuals that had lost their mates or were otherwise disturbed whilst breeding.

June 20 and 21, great flights of young birds; 22nd, 23rd, and 24th, enormous numbers of young birds; up to the end of the month thousands of young birds daily.

July 1 to 12, from a thousand to ten thousand young birds daily; 16th, many flights of hundreds; 25th, great many young birds.

Then follows a pause of two months during which no starlings whatever were seen, the migratory move being taken up again on September 22, when I find noted down:—

Starlings, old birds in fresh plumage, flights of many hundreds.

October 2 and 7, great many old birds; 8th, flights of thousands; 13th, Royston crows and old starlings by tens of thousands; 14th, crows many thousands, starlings hundreds of thousands; 15th, many; 16th, a few only; 20th, tens of thousands; 28th, great many.

November 18 and 19, flights from twenty to fifty.

December 9 to 18, flights from forty to sixty daily.

Thus I have witnessed the autumnal migration of the old and young starlings during the long series of years above stated. Invariably nothing but young grey birds pass over here (and in a broad front extending to both sides of the island) from the latter part of June to the end of July; then a pause ensues lasting from six weeks to two months, when during the latter part of September the movement is taken up again by the old birds in fresh black plumage, and continued to the close of November—by straggling parties oftentimes kept up till Christmas.

These are incontestable facts, however incredible they may appear to Dr. Weismann; but he may rest assured that not only all the young and old starlings passing over here *are* "*inspected*," but the many hundreds of thousands of miscellaneous birds visiting this island have to pass a very critical review in addition.

I cannot conclude these remarks respecting the question of young birds preceding during their first migratory trip their parents by one or two months, without stating that, so far as my long experience on Heligoland extends, there exists, among the 360 odd species collected here by myself, only one solitary exception to the general rule, viz., the cuckoo, *Cuculus canorus*, of which species the *old birds precede* their young by at least four weeks. Of all the rest, the young birds of the summer open the grand autumnal flight, *unaccompanied by any old*, the very finest old males at the close of the season bringing up the rear. In spring, however, *quite the reverse invariably takes place*, then the most perfect old males appear first, followed soon by old females, and later by younger birds of less perfect

appearance, in this instance the rear being brought up by the halt and lame: crippled birds that have lost a greater or less number of their wing or tail feathers, some toes, or even a whole foot.

All this is very strikingly exemplified here by the blackbird, for instance, with its varying dress according to age and sex, and this might with some attention be observed at other places also, though in the middle and south of England and Germany such observations become greatly more complicated, on account of the immigrants from the north mixing with such of the same species as have been breeding in these more southern latitudes, and where the grand opening migratory rush, as witnessed here in full original purity, has more or less relaxed in a *con amore* travelling by easy stages. H. GÄTKE

Heligoland, May 7

THE U.S. NATIONAL ACADEMY

ONE of the chief scientific events of the year in the United States is the annual meeting of the National Academy of Sciences, the most select scientific body in America, election to which is regarded as stamping a man as an acknowledged leader in science. This year the meeting took place at Washington from April 15 to 18, the acting president being Prof. O. C. Marsh, who opened the proceedings with a review of the Academy's official work during the previous year. He had to record the great loss sustained by the Academy in the death of its president, Prof. Joseph Henry, on May 13 last year. Henry had been president of the Academy for ten years. One of the principal functions of the Academy during the past year was the consideration of a plan for the reorganisation of the U.S. Surveys, to which we have already referred at length.

At the meeting of the Academy in April last year a resolution was adopted authorising the appointment of a committee to consider a plan proposed by Prof. Newcomb for determining the distance of the sun by measuring the velocity of light. In accordance with this vote, Prof. Marsh appointed as members of the committee, President F. A. P. Barnard, Professors Wolcott Gibbs, Henry Morton, George F. Barker, and E. C. Pickering. Their report was so favourable to the plan proposed that Prof. Marsh sent it to the Secretary of the Navy for transmission to Congress. An appropriation of 5,000 dols. for the required purpose was thus secured, and the work of constructing the necessary apparatus will be commenced as soon as the appropriation is available. The expenditure of the funds is entrusted to the Secretary of the Navy. It is hoped by those who proposed this plan that the experiments will lead to a more accurate determination of the distance of the sun than can be obtained by any other method known to astronomy.

Prof. William B. Rogers was elected President of the Academy, to fill the vacancy caused by the death of Prof. Henry. The election is a deserved tribute to Prof. Rogers, who has for half a century held a prominent place among American men of science. He was for many years a leader among American geologists in adopting the modern theories of evolution, and defended his views with rare eloquence as well as strong argument. During his connection with the Massachusetts Institute of Technology (1862–68), the health of Prof. Rogers became so much impaired that he was obliged to withdraw from all studious pursuits for a long period. His recovery of health was the occasion of hearty congratulation in 1875, when he was for a second time elected President of the American Association for the Advancement of Science. The new president is loved by everybody, is venerable with silver locks, and still retains the silver-tongued eloquence for which he used to be famous. But he is by no means rugged, and has to take care not to over-exert himself.

Many valuable papers were read during the meeting of the Academy, but our space will only permit of our referring to a few. We append a complete list, and those who desire a complete report of the Academy's proceedings will find it in *Science News* of May 1 and following numbers.

Two papers were presented by Mr. Peirce, entitled respectively, "On Ghosts in Diffraction Spectra" and "Comparison of Wave-Lengths with the Metre." It is well known to users of diffraction spectroscopes that ghosts of the lines appear in the images. Mr. Peirce has investigated this subject from a mathematical point of view, and he presented to the Academy a series of calculations based on the conditions which call forth these ghosts, and concluding with formulæ for determining their positions. In conjunction with Mr. Rutherfurd, Mr. Peirce has been investigating the relation of the wave-lengths of light to the metre. The object is to obtain a basis for measuring the standard metre. The metres that have been issued as standards change in length after a lapse of time. The German metre is said to differ from the French metre by one 25,000th. Mr. Peirce proceeded on the assumption that the wave-lengths of light are of a constant value. Certain questions have arisen in the course of this research. It was necessary to ascertain whether the spectral lines were fine enough to serve the purpose. There was a doubt as to whether the lines were displaced by "ghosts," and this led to the mathematical inquiry, previously alluded to, which has defined the position of ghosts relatively to the lines. Again, it was found needful that the spectrum to be observed should be at its maximum of brilliance. It had been noticed that two spectra composing a pair (that is, of the same order) are usually of different brightness, the right side spectrum differing from the left side one. This was specially true of spectra obtained from ruled glass; those from speculum metal were not so notably diverse in brightness. Examination showed that this characteristic was due to a difference in the sides of the groove ruled in glass. The diamond, in ploughing through the surface, raises a burr on the side of the furrow, and hence makes the two sides of the cut of unequal height. At first it was attempted to remove this imperfection by rubbing off the burr; but it was found that the material of the burr went to fill up the groove, and thus rendered the glass plate unserviceable. But, by first filling the groove with black-lead, then polishing off the burr, and finally removing the black-lead, plates were obtained that gave spectra of the utmost brilliancy, and the right and left spectra of each pair did not differ in brightness from each other. Mr. Peirce also gave the particulars of other improvements recently made in spectroscopic apparatus. One of these involved the construction of glass circles, and the work was so delicate that a well-known instrument maker had failed in four attempts. A method was described by which the accurate focussing of the heliostat—a matter of great importance—had been satisfactorily attained. The experimenters have succeeded in measuring a number of decimetre scales by centimetres. The probability of a single error is within the fiftieth part of a micron. (A micron is as much smaller than a millimetre as the latter is less than a metre.) Means have been devised which keep the apartment, where the experiments are made, at a fixed temperature, within one-tenth of a degree of Fahrenheit. With a sufficient number of observations, and the use of apparatus having their latest improvements, these experimenters hope to attain the object of their research, and limit the error to one-millionth part of a wave-length.

Prof. E. C. Pickering's paper on eclipses of Jupiter's satellites was one of considerable importance. He showed the value of the photometric method of observing these eclipses, and the valuable data that might be obtained by improvements in this method, both as to the sun's distance and as to Jupiter himself and his satellites.

In a paper on the winds on Mount Washington compared with the winds near the level of the sea, Prof. Elias Loomis came to the following conclusions:—1. In a majority of the cases where an area of low barometer passes over New England, attended by the usual circulating winds at the surface stations, this system of circulating winds does not extend to a height of 6,000 feet. 2. This system of circulating winds extends to the greatest height when the depression of the barometer is unusually great. 3. When, during the progress of an area of low pressure, a system of circulating winds reaches to the summit of Mount Washington, the change of wind to the east quarter usually begins at the surface stations eleven hours sooner than on the summit of the mountain; and the change back from east

to west usually begins five hours sooner at the base than at the summit.

Prof. Joseph Le Conte's paper on the extinct volcanoes about Lake Mono, and their relation to the glacial drift, was of much interest. The general form of the Sierra is that of a great wave, ready to break on its eastern side. It rises from the San Joaquin Plains by a gentle slope of fifty to sixty miles, reaches a crest 13,000 feet high, and then, in a space of five or six miles, plunges downward steeply to the plains of Mono, which are at an altitude of only 6,000 feet. In former periods, long, complicated glaciers, with many tributaries, occupied the western slope; on the east, comparatively short and simple glaciers came down in parallel streams, and stretched far out on the plain and into Lake Mono, which was then 700 feet above its present level, and of far greater extent than now, so that it washed the base of the Sierra. Icebergs from the glaciers floated on this inland sea and dropped *débris* on its bottom. Around the present lake is a nearly level desert plain, covered with volcanic sand, interspersed with fragments of pumice and obsidian, and overgrown with sage-brush (*Artemisia tridentata*). This plane is an old lake bottom; the volcanic ashes are a later deposit upon it. The desert is relieved by the Sierra walls, with deep cañons; by long parallel moraine ridges, stretching like arms from the mouth of each cañon, and bounding the pathways of ancient glaciers; by a cluster of recently extinct volcanic cones, fifteen or twenty in number; and, finally, by the bright waters and picturesque islands of the lake. The moraines average 300 to 406 feet in height, and five or six miles in length. Lake Mono is ten by fourteen miles in extent. Having no outlet, its waters are saline—essentially a strong solution of sodium carbonate, with smaller proportions of calcic carbonate, common salt, and borax. Four to six terraces are very distinct about Lake Mono. Some of these are traceable all the way around it; the highest is, according to Whitney, 680 feet. They are undoubtedly the remains of former lake-levels. The highest level would reach the moraines at the foot of the Sierra. Near the centre of the lake is a group of volcanic islands in a line with the group of volcanic cones on the plain to the southward. Steam and boiling water issue in many places in the rocky part of the island and in the shallow waters of that vicinity. The twenty or thirty volcanic cones on the plain vary in height from 200 to 2,700 feet above the plain. Some of them are probably recent, and retain a perfect form. Prof. Le Conte adduced evidence to show that the eruptions were—at least in part—more recent than the glaciers, and that many of the volcanoes themselves were also of later date than the Champlain epoch to which the glaciers are assigned. From his observations on Lake Mono, Prof. Le Conte concluded that its level is again rising, and that this had been going on for ten or fifteen years. He found near the margins of the lake, sheep-corral fences and old trails, submerged many feet. He also found dead sage-brush (*Artemesia tridentata*) and greasewood (*Sarcobatis vermiculatus*), that were under five feet of water. Neighbouring residents estimate the rise of the lake as ten to twelve feet in ten to fifteen years. The cause is evidently an increase of rainfall, and especially of snowfall. With regard to a moving snowfield, or rather an imperfect glacier, on Mount Lyell, Prof. Le Conte finds signs that the ice is advancing.

In a paper on vowel theories in the light of recent experiments with the phonograph, Prof. Graham Bell discussed the whole subject, and gives an account of his own recent experiences. Prof. Bell formulates his research as follows:—We may adopt the "fixed pitch theory," which supposes that the partial tones characteristic of vowel sounds have fixed, invariable pitches; and the element of pitch may be considered the distinguishing feature; or we may adopt the "harmonic theory," which assumes that the partial tones are harmonics of the fundamental, varying in pitch with it; the vowel characteristic lying in the predominance of certain harmonics. The fixed pitch theory finds much support from a consideration of the mechanism of speech. Various experiments, of which Prof. Bell exhibited a considerable number, tend to bias the mind in favour of this theory. But in a series of careful experiments with the phonautograph it was found that (1) Vowel sounds uniformly produced periodic curves, whatever pitch of voice was employed; (2) The form of vibration was not a stable phenomenon; (3) Different vowels, sung to different pitches, often produced sensibly similar curves; (4) Different vowels sung to the same pitch yielded curves of different shapes; but the differences were not so well marked as to identify the vowels; (5) The size of the aperture seemed to influence the complexity of the tracing. Prof. Bell tried a phonantograph made with the tympanic membrane of the human ear, but obtained no different results. The general indications of the phonautograph thus favour the harmonic hypothesis. The phonograph was finally tried to help in solving this problem. Other experimenters have tested the instrument on this point. After describing their experiments and results, Prof. Bell gave the details of his own. By changing the speed of the phonograph, such words as "mean, mane, men," were altered (approximately) to "moon, moan, morn," and the reproduced ee became a faint oo. Different opinions as to these sounds are entertained by others who have experiments of a similar character, but all of the numerous researches made on this subject confirm Prof. Bell in his view that the phonograph answers the question of vowel fixity in the negative. Some very recent experiments, made by Prof. Bell and Mr. Francis Blake, conjointly, not only demonstrate that the vowel quality changes under varying speed of the phonograph cylinder's rotation, but also show the direction and nature of the change. This was shown by starting the cylinder at a given velocity, and letting it slowly come to rest. During this reduction of speed the vowel-sound "ah" changed successively from "ah" to "awe," "oh," and "oo." (The same effect can be produced by gradually contracting and rounding the orifice of the lips, while, at the same time, the back of the tongue is slightly raised.) With decreasing rapidity of the cylinder, the prime tone and the partial tones fall simultaneously in pitch. If a gradually increasing velocity was employed, the vowel-sound "ah" gradually changed to that of "ir" in "sir," and then to that of "a" in the word "man." Meanwhile, the quality of the sound became metallic. These facts favour the fixed pitch theory. Prof. Bell approves the suggestion of Ellis, that "what we call our vowels are not individuals—scarcely species—but rather genera, existing roughly in a speaker's intention; but at present mainly constituted artificially by the habits of reading and writing. Of the two hypotheses it is certain that one (the harmonic) is wrong, and the other only partly right. Treating vowels as we find them—as genera of sounds instead of individuals—the most plausible theory seems to consist in what we may term the "Harmonic Fixed Pitch Theory," according to which a vowel is a musical compound composed of partial tones whose frequencies are multiples of the fundamental of the voice, the predominant partials being always those that are nearest in pitch to the resonance cavities formed in the mouth by the position of the vocal organs assumed during the utterance of the vowel. An interesting discussion followed the reading of this paper. Prof. A. M. Mayer remarked that it is exceedingly difficult to obtain uniformity of results in analysing vowel-sounds. One curious experiment made by Prof. Mayer consisted in covering the ears of a human subject with soft wax, so that they were hermetically sealed, and then applying to the top of the head an instrument which gave forth a certain note. The person thus treated heard the note one octave higher than it was actually sounded. On the whole, it must be admitted that we know very little of physiological acoustics.

The following is a list of the papers read at the meeting of the Academy:—

C. S. Peirce—On Ghosts in Diffraction Spectra; On Comparison of Wave-lengths with the Metre; On a Method of Swinging Pendulums, proposed by M. Faye; On the Errors of Pendulum Experiments; On Projections of the Sphere which still Preserve the Angles. S. H. Scudder—The Palæozoic Cockroaches. Henry Draper—Conformation, by Spectrum Photographs, of the Discovery of Oxygen in the Sun. S. Weir Mitchell—The Relation of Neuralgic Pains to Storms and the Earth's Magnetism. Joseph Le Conte—On the Extinct Volcanoes about Lake Mono, and their Relations to the Glacial Drift. E. D. Cope—On the Extinct Species of the Rhinoceros, and Allied Forms of North America. E. W. Hilgard—The Loess of the Mississippi and the Æolian Hypothesis. J. E. Hilgard—An Account of Geodetic Arcs determined by the Coast Survey in Relation to the Figure of the Earth; an Account of Recent Comparison of the British Imperial Standard with its Copies sent to the United States. J. E. Hilgard—Report of Progress of the International Bureau of Weights and Measures at Paris. G. K. Gilbert—On the Stability and Instability of Drainage Lines. E. C. Pickering—Eclipses of Jupiter's Satellites; two New Forms of Micrometer. C. V. Riley—The Hibernations and Migrations of *Aletia argillacea* (the parent of the cotton-worm). Alfred M. Mayer—Description and Exhibition of a

New Form of Heliostat. C. F. Chandler—A New Polariscopic Method for the Detection and Estimation of Dextro-glucose in the Presence of Cane Sugar and Inverted Sugar. A. Graham Bell—Vowel Theories considered in the Light of Recent Experiments with the Phonograph and the Phonautograph. Elias Loomis—The Winds on Mount Washington Compared with the Winds near the Level of the Sea. Henry L. Abbot—The Ignition of High Tension Fuses. Alexander Agassiz—Report on Dredgings in the Caribbean Sea by the Coast Survey Steamer *Blake*, Commander, John R. Bartlett, U.S.N. C. F. Chandler—On Two New Diazo Colours from Coal Tar. G. J. Brush—On a Mineral Locality in Fairfield County, Connecticut. H. A. Newton—On the Influence of Jupiter on Bodies passing near the Planet. J. S. Newberry—On the Great Silver Deposit recently Discovered in Colorado, Utah, and Nevada. Simon Newcomb—On the Recurrence of Solar Eclipses. F. A. P. Barnard—Report of the Committee on Weights, Measures, and Coinage.

NATIONAL WATER SUPPLY

THE Society of Arts has again done useful work in bringing together a jury of experts on the question of water supply; for though the subject has engaged public attention for nearly half a century, has been investigated by Royal Commissions, and inquired into by committees appointed by scientific societies, we still find ourselves face to face with so costly and cumbersome a system of legislature, that although the country receives a rainfall which has been amply demonstrated to be far in excess of all the requirements of human consumption, manufacturing interests and purposes of canalisation, we see large districts suffering all the ills due to a polluted water-supply, whilst in other areas excessive rainfall is passing to the sea in devastating floods.

It is obvious, from a consideration of this fact, that there exists but *one* remedy for this state of things—the creation of a central authority, with power over the whole water-rights of the country for all purposes whatsoever; and upon this point there is a most striking unanimity of opinion in all the speakers attending the Society of Arts conference this year and last. Whether this authority should be placed over the whole of the 215 river basins of England and Wales, or whether they should be subdivided into groups, each presided over by separate bodies, is a question of detail, and it is necessarily one which allows of a very large amount of difference of opinion, varying with the special knowledge and tendencies of the individual propounding the scheme.

Sir Henry Cole last year suggested a division into seven districts, each under a local commission, assisted by a well-known engineer, together forming a united board, for the discussion of general questions.

Mr. Shelford pointed out that 158 river basins are contained in one county, and might be presided over by county boards, while only eleven rivers are situated in four or more counties, for which he considers special legislation would be necessary. Mr. De Rance would divide the country into six groups of river basins, Mr. Conder into ten, and he suggested the formation of a board similar to the Hydraulic Works Department in Italy, who at once take charge of the area and population of each province, the altitude of the ground, the volume of the rivers, and the amount of rainfall.

To elicit information as to the best means of dividing the country into separate watershed areas, having regard to the wants of the population and the geological and hydrological conditions, the Society of Arts offered for competition, at the Congress just held, a gold and three silver medals. No paper, it appears, has been judged of sufficient value to entitle the author to the gold medal, but two, of the seven papers selected for printing, have been thought worthy of silver medals, contributed by Mr. F. Toplis and Mr. J. Lucas. The former proposes that the country should be mapped out into watershed districts of one or more river basins, governed individually by a body of commissioners, assisted by competent legal and engineering advisers, with charge over all rivers, and power to acquire all existing water-works and canals, acting under the direction of a Minister of Health.

Mr. Lucas divides the country into northern, midland, and southern districts, with the idea of giving the commissioner presiding over each area a similar disposition of mountains and plains and constituent geological strata.

Other authorities propose still other subdivisions, and we cannot but think that the legislative creation of a numerous body of commissioners, in various districts, each with varying requirements and conflicting vested interests, would for the present only tend to increase the existing confusion; for, as we stated last year, quoting Dr. Child, "the bane of all local government in England is the chaos of different and often conflicting authorities, existing each for a special purpose." It is difficult to see how this state of things would be improved by the large powers proposed to be given to a number of new local governing bodies. For ourselves we are more inclined to agree with Capt. Douglas Galton, that all existing information should be brought to one focus, and though this information lies scattered over many departments, the Local Government Board is the legitimate focus for it; and that whether or no it is considered necessary that a Minister of Health be appointed, the preliminary step which can at once be taken is to place the heads of departments who hold information in official relation with the Local Government Board. The departments he specially referred to, being the Geological Survey, the Ordnance Survey, the Register-General's Department, and the Rainfall Committee.

The maps of the Ordnance Survey that would be most useful for hydrological purposes are those on the scale of six inches to the mile, published for the six northern counties, part of Flintshire, and for the neighbourhood of London; but unfortunately for those who have recognised the practical value of the maps on this scale, for economic purposes, the Directors of the Ordnance Survey have given priority of appearance to the larger 25-inch maps, which in addition to the objection found to their use, from the small area they include, do not contain the contour lines of equal level, which give to every 6-inch map the usefulness of a model. The Ordnance Survey are, however, bringing out a new issue, brought up to date, of their 1-inch map of England and Wales, reduced from their 25-inch map; this new 1-inch map has no hill-shading, which so often obscured the topography of the older editions, but in its place contains the principal contour lines. This map will form an admirable basis for tracing the watersheds and other hydrological purposes for which the published Ordnance Survey Catchment Basin Map is far too small.

The information collected by the Geological Survey, consists of geological maps of a large region on the scale of one inch to the mile, and of maps on the six-inch scale in the northern counties, coloured for the geological formation, and "stippled" for the superficial clays and sands with which they may be overlaid; sections across country on the six-inch scale, showing the thickness of the various permeable and impermeable formations; memoirs descriptive of districts, and including the more minute details of the strata, and particulars of the well-sections. On the latter head we would specially allude to the exhaustive detail of wells, given in the memoir of the London basin, by Mr. Whittaker, which has furnished so practical a basis for the useful investigations of Mr. Lucas, who has added to them, from personal examination, the level of the underground water in the metropolitan area.

From information supplied by Mr. De Rance to the conference, it appears that the *pervious* water-bearing formations occupy about 22,000 square miles, absorbing on an

average about ten inches of rainfall a year, which, if all yielded up to wells, would give a daily average supply of 400,000 gallons per square mile, and he further shows that the larger area of these permeable formations lies east of the great water-shed, dividing England diagonally, and separating the Severn and Trent basins on the one side, from those of the Thames, east coast streams, Witham and Ouse on the other, the only important previous formation west of this boundary being the permian and new red sandstones. The latter occupies an area of 3,190 square miles.

This different disposition of the permeable and impermeable strata in England, at once explains how it is that the dry-weather flow of rivers like the Thames, draining a basin largely consisting of permeable strata, differs so remarkably in volume from rivers like the Severn, mainly occupied by impermeable silurian rocks and triassic marls, and the necessity is at once apparent of there being a *central authority*, taking cognisance of all matters bearing on water questions, and assisting parliament in giving or withholding to any corporation or district the water rights of any area to which they may lay claim. Thus, in the case of Liverpool, it is proposed to take from the sources of the Severn, a quantity of not less than 52,000,000 gallons a day, while Mr. Hawksley, in evidence before the Royal Rivers Commission, gives the driest weather flow, so low down the Severn as Tewkesbury, as only 90,000,000 gallons per day. With a margin so small, it is obvious that the maintaining of a sufficient volume of water for navigation, fisheries, and other purposes, is of national importance, and should be the subject of imperial care.

The basis of all calculations of the body of water available for gravitation purposes must of necessity be an accurate record over numerous localities of the amount of *rainfall*, and it is a matter of regret that the work carried out by Mr. G. T. Symons is not incorporated with the Meteorological Department of the Government. In 1865 the British Association appointed a Committee to assist Mr. Symons in developing the system of registration; the total number of stations now at work exceed 2,000, and the correspondence with these observers, the verification of their instruments and codification of their observations necessarily incur a large amount of expenditure. The British Association, after many years' support of the work, feeling it their duty rather to initiate than permanently subsidise investigations, have at length discontinued their grant, and the only sources with which this work of national importance to the country can be carried out by Mr. Symons are voluntary subscriptions and the profits on the annual sale of the volume of "British Rainfall." We trust that one result of the Congress may be to place this work on a more permanent and satisfactory basis, and also that the Ordnance or Geological Survey be charged with the gauging of the chief streams of the country, so that data may be furnished for really estimating what amount of rainfall at *once* runs off in impermeable districts, and how much is absorbed in permeable districts, without which all calculations as to probable yield are to a great extent hypothetical.

It is the fashion in some quarters to abuse the Local Government Board, but when it is realised that they have no authority given them by legislation to survey the country, seek out abuses, suggest and compel improvements,—until they are called to inspect often by the authorities who have allowed abuses to devastate a particular district,—we think that those who read their annual report of work will give them the greatest credit for the industry and ability with which, often at much personal discomfort, they track not only the fever-germs to their source, but confront the ignoranc and obstinacy of the small local authorities. We hoepe that the action of the Society of Arts, in bringing these matters prominently before the country may lead to the scope of the Local Government Board being so enlarged, their staff increased, and their sources of information widened, that they may become a Department of Health, ever ready not merely to find out the cause of disease, but to prevent the possibility of its occurrence. Towards this end, in rousing public opinion to the exigencies of the question, these congresses cannot be, perhaps, too highly valued. Already out of the congress held this year, a National Water Supply Exhibition has been inaugurated at the Royal Aquarium, which cannot but tend to popularise the subject, and if it should be possible to find the Exhibition a permanent home, at the South Kensington Museum, it would add an important factor to the already high educational value of that institution. Should a wider knowledge of these subjects become general, and the government legislate in the direction suggested by the Society, it will be felt that its President, the Prince of Wales, in first bringing the subject prominently before the Society, and in lately placing it before the Premier, will have been instrumental in bringing about the once almost Utopian hope of Charles Dickens, in his preface to the Pickwick Papers, that the time will come when "a few petty boards and bodies—less than drops in the great ocean of humanity which roars around them—are not for ever to loose fever and consumption on God's creatures, at their will, or always to keep their jobbing little fiddles going for a Dance of Death."

THE AUDIOMETER

ALREADY have experiments of the greatest practical value been made with the wonderful invention of Prof. Hughes described in our last number. Dr. B. W. Richardson has been applying it in two ways: as an Audiometer for the measurement of hearing, and a Sphygmophone for measuring the pulse. Both applications were described at the last meeting of the Royal Society.

The audiometer, as it had been used, was shown to the Society. It consists of two Leclanché's cells for the battery, a new and simple microphonic key connected with the cells and with two fixed primary coils, and a secondary or induction coil, the terminals of which are attached to a telephone. The induction coil moves on a bar between the two fixed coils, and the bar is graduated into 200 parts, by which the readings of sound are taken. The graduated scale is divided into 20 centims., and each of these parts is subdivided into 10, so that the hearing may be tested from the maximum of 200 units to 0°—zero. The fixed coil on the right hand contains 6 metres of wire; the fixed coil on the left hand contains 100 metres. By this means a long scale from the left hand coil is produced. The secondary coil contains 100 metres of wire.

In using the instrument, the induction coil is moved along the scale from or towards the larger primary, as may be required, and the degrees or units of sound are read from the figures on the scale, the sound being made by the movement of the microphonic key between the battery and the primary coils.

The instrument may be considered to afford the most satisfactory means for testing the hearing power of all persons who can define a sound. The range of sound is sufficient at the maximum—200°—for every one who is not absolutely deaf; 0°, or zero, is a point of positive silence from the instrument, or rather from the sound which it produces through the telephone.

One of the first facts learned with the audiometer is the suddenness with which the sound is lost to those who are listening. The sound is abruptly lost within a range of 2°; that is, within one-hundredth part of the entire scale. This is the case with those who are very deaf as well as with those who hear readily.

In testing the capacity of hearing, it is noticeable that the power to detect the diminishing sound is maintained best by continuing the reduction in trace or line while the attention is fixed. A sudden break may cause the sound to be lost to the listener long before his real incapacity to hear is reached. If, for instance, the sound be very faintly heard at 15°, and the induction coil be suddenly moved to 5°, the sound at 5° may be quite inaudible; but if the coil be slowly moved, unit by unit, from 15° to 5°, the sound at 5° may be distinctly heard.

The effect of filling the chest and holding the breath makes a difference in listeners. The capacity for hearing is for a few seconds increased by holding the breath. Holding the breath with the chest not full fails to produce the same result.

As a rule, the hearing of persons who are right-handed is most refined in the right ear, and as most persons are right-handed, it is found that the right ear is the best ear. This rule is, however, attended with many exceptions, since, for various reasons, some persons who use the right hand exclusively, practise for some particular purpose the use of the left ear, upon which that ear becomes more acute. Another point of interest attaching to this observation is, that the practice of using one ear for special refinement of the sense seems for the time slightly to impair the other ear, although there is no physical evidence of such impairment.

Connected with the last-named fact is another, namely, that by this instrument the deaf are found to fail in capacity of hearing not only by reason of physical defect, but also by failure of memory of sounds. Thus in a youth who had suffered serious defect of hearing for seven years, owing to partial destruction of the tympanum, and who in the right ear could only detect sound at 107°, there was an inability to catch all the sound lying between 130° and 107°, until he could remember what he had to listen for. By practising him then to detect the lowest sound that he was physically capable of receiving, Dr. Richardson got him to detect this one sound more readily than those which came higher up. By further practice all the intervening sounds became audible with equal facility.

By use of the audiometer the influence of atmospheric pressure on hearing is detectable. In Dr. Richardson's own case, when the barometer is at 30° he can hear on both sides close down to zero; but below 30° he fails by 2° on the left side to reach zero. In another person a similar failure extends to a loss of 4°.

Dr. Richardson has tried to determine in some of the lower animals whether there is the same sense of hearing as in man. In two dogs, one a terrier, the other a field spaniel, the range of hearing power seemed to be distinctly lower than it is in the human subject who has perfect hearing. In both these animals, which were healthy, and in the prime of life, the first indication of the detection of sound commenced at 10° on the scale.

Dr. Richardson's practical conclusions are—

1. The audiometer will, he thinks, be an essential in all physical examinations of men who are undergoing examination as to their fitness for special services requiring perfect hearing, such as soldiers, sentries, railway officials, and the like. 2. The instrument will be of great use to the physician in determining the value of hearing in those who are deaf, and in determining the relative values of the two organs of hearing. 3. In other forms of diagnosis he has found the instrument useful, as in anæmia and vertigo. 4. The instrument may be used to differentiate between deafness through the external ear and deafness from closure of the Eustachian tube—throat deafness. 5. The instrument promises to be very useful in detecting the effects in the body of those agents which quicken or excite the circulation, such as alcohol and other similar chemical substances. 6. The instrument promises to be of great service in determining the value of artificial tympanums in instances of deafness due to imperfection or destruction of the natural tympanum. Dr. Richardson finds in fine gold the substance for making the most useful and effective artificial drum.

The sphygmophone, for obtaining a secondary or telephonic sound from the movements of the pulse at the wrist, is devised by adding a microphone to a Pond's sphygmograph. Dr. Richardson mounts on a slip of talc, glass, or wood a thin plate of platinum or gas carbon. He places the slip in the sphygmograph as if about to take a tracing of the pulse. One terminal from a Leclanche's cell is connected to the platinum or carbon, and the second terminal from the cell to a terminal of the telephone, the other terminal of the telephone with the metal rod of the sphygmograph which supports the slip. The instrument is placed on the pulse, in the ordinary way, and is adjusted, with the writing needle thrown back, until a good pulsating movement of the needle is secured. The needle, in passing over the metallic plate, causes a distinct series of sounds from the telephone, which correspond with the movements of the pulse. The sounds are singular, as resembling the two words, "bother it." The sounds can be made very loud by increasing the battery power.

In this connection we may state that in the last number of *La Nature* a micro-telephonic explorer is described, also evidently of great use in pathology. This is a simple instrument, devised by MM. Charden and Prayer, consisting of a telephonic apparatus with microphonic intermediary to intensify any sounds sought for, and which, among other purposes, will be of great service in detecting any foreign body in a vital organ. The apparatus is quite portable and worked with comparative ease, though doubtless actual practice will suggest improvements both in this and in the applications devised by Dr. Richardson.

A MACHINE FOR DRAWING COMPOUND HARMONIC CURVES[1]

HARMONIC curves possess great importance, since they represent to the eye the circumstances of motion of bodies in a state of vibration, and hence apply not merely to the pendulum and to musical instruments when giving their tones, but also to the particles of air during the transmission of sound.

The study of these curves offers us two problems of almost equal importance and interest, viz.: First, Given the curve; required, to find its component simple elements. Second, Given the component simple curves; required, to construct the resulting compound curve. From the standpoint of acoustics these problems may be stated thus: First, Given a complex sound, required to find the simple musical tones of which it is composed. Second, Given the intensity, pitch, and phase of each of a number of pure musical tones; required, to find the effect of their simultaneous action on the air.

The laborious investigations of Donders, Helmholtz, and others into the constitution of the simplest elements of speech—the vowel sounds—show that the actual analysis of the simplest articulate sound is no easy matter. When the curve corresponding to the sound is once obtained, Fourier's theorem enables us to subject it to mathematical analysis, and thus determine by a somewhat laborious process, its simple harmonic elements. Three methods give us such curves. König[2] employed two tuning-forks, to actually draw the curve belonging to their combination; this method is limited to combination of two simple tones. Messrs. Jenkin and Ewing[3] magnified the impression made on the tin-foil of the *phonograph*, obtaining thus the curve belonging to the sound impressed on the vibrating disk.

[1] Abstract of Paper in the *American Journal of Otology* for April, by Prof. E. W. Blake, Brown University.

[2] *Poggendorff's Annalen*, Bd. clvii. S. 177, 1876.

[3] NATURE, May 9, 1878: July 25, 1878.

A third method[1] is the photographing of the vibrations of a disk set in vibration by the sound to be analysed. The curves are drawn with great sharpness and seem to offer the best means for pursuing this investigation. It was the study of these photographs which led Prof. Blake to consult with Prof. H. A. Newton, of Yale College, on the possibility of producing similar curves by mechanical means. Prof. Donkin, F.R.S., had described a machine by which the combination of any *two* simple tones could be drawn,[2] but the apparatus was not available for more complex combinations. The machine now to be described was the result of this consultation.

Fig. 1 represents the machine. A, A^{i}, A^{ii}, A^{iii}, A^{iv}, A^{v}, are T-shaped pieces of sheet brass, sliding between screws, motion being given to each by a crank-pin entering a slot cut in the cross-bar of the T. Each crank is driven by a pulley which is set in revolution by a string passing completely around it. The wheel B serves to return the string to the tightening pulley, D, which gives or takes up the "slack" when the crank-pulleys are changed. Firmly attached to B, and revolving on the same axle, is a smaller wheel which drives the roller feeding the paper on which the curves are traced. To secure the necessary tightening of the second string, the axle of B is inserted in the end of a wooden bar which slides horizontally under the frame. The strain given by D having tightened the string sufficiently, this bar is clamped by the thumb-nut, F.

The driving roller, G, is covered with sand-paper, and the pressure of the companion roller, H, secures the feed of the paper between them. A small brass wheel, C, is pressed by the spring of its steel axle on the middle of the paper strip. It has a sharp edge, and prevents lateral motion of the paper liable to result from friction of the pencils.

E, E^{i}, E^{ii},, are strips of brass sliding between screws. Each has a steel spring attached to it, to the end of which a thick piece of brass is soldered. A hole through this brass is tapped with a screw thread, into which the pencils (or tubular pens) fit and are readily adjusted to the desired height. E, E^{i}, and E^{ii}, have each a steel pin projecting upward from their middle points. Similar pins project from points near the ends of A, A^{i}, A^{ii}, &c.

A cross-bar connects the pins A^{i}, E^{ii}, and A^{ii}, the joint at E^{ii} admitting simply of revolution, while at A^{i} and A^{ii} there are slots in the bar permitting both rotation and sliding. A^{iii}, A^{iv}, and E, are similarly connected. A third cross-bar connects E and E^{ii} with E^{i}, having slots at E and E^{ii}, and a simple rotary joint at E^{i}.

A is not represented as in action, in order not to complicate the drawing and description unnecessarily. It would be connected by a cross-bar with E^{i}, and a fourth slider (E^{iii}) placed midway between A and E^{i}.

The operation is as follows:—Imagine a strip of paper fed between the rollers and passing under the pencils. The pulleys revolve by the action of the string, and their cranks give the respective T's movements which are the rectilinear components of the circular movements of the crank-pins. A pencil attached *directly* to any one of the T-s, would therefore draw on the paper a simple harmonic curve,[3] whose "period" depends on the diameter of the pulley, and whose amplitude depends on the length of the crank-arm. The connection of the cross-bars with E and E^{ii}, compels these strips to perform movements which are respectively *one-half* those of $A^{iv} + A^{iii}$, and $A^{ii} + A^{i}$. Hence, from the pencil in E, we get a curve combining A^{iv} and A^{iii}, but having ordinates of one-half their sum; from the pencil in E^{ii}, a curve combining A^{ii} and A^{i}, in like manner. Finally, the cross-bar connecting E and E^{ii} determines a movement of E^{i} which is *one-fourth* the sum of the movements of the four T-s, and, therefore, E^{i} describes upon the paper the curve belonging to the chosen relations of "period," "amplitude," and "phase."

The relations of these three terms may be varied to any extent (within practical limits), and with great ease. The accuracy with which a definite period may be obtained without the use of gearing, is quite surprising.

Specimens of the curves obtained are given in Fig. 2.

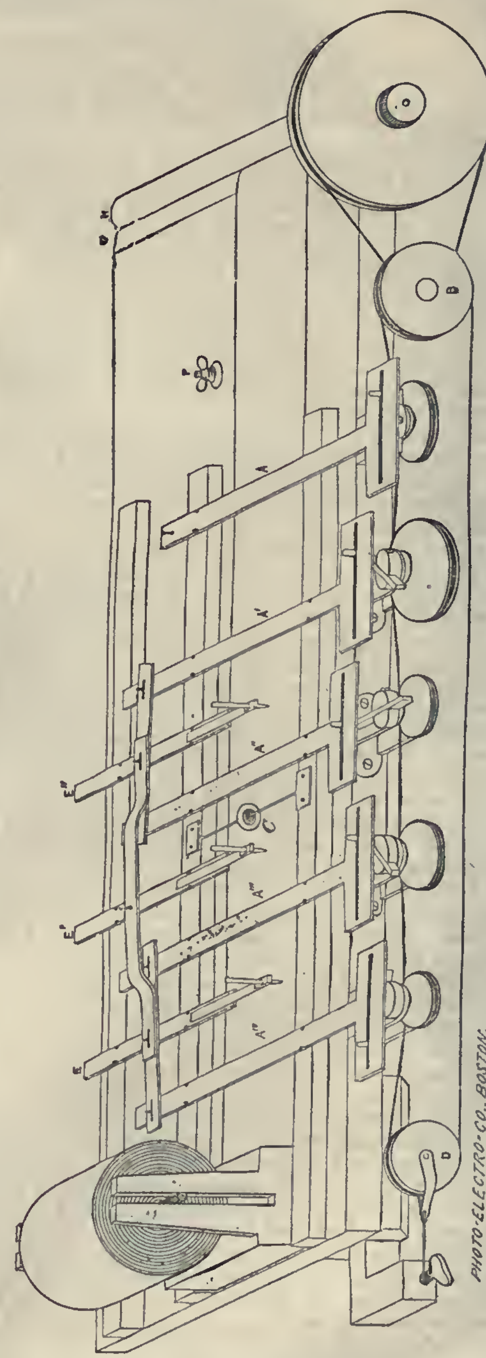


Fig. 1.

Nos. 1 to 8 (inclusive) are combinations of the first four terms of the Harmonic Series:—

Ratios of vibration	1 : 2 : 3 : 4.
Amplitudes of vibration	1 ½ ⅓ ¼.

[1] *Silliman's American Journal*, vol. xvi., 3rd Series, July, 1878. NATURE, July 25, 1878.

[2] Royal Society *Proceedings*, xxii. p. 196. British Association *Reports*, 1873, xliii. p. 65.

[3] This method of drawing simple harmonic curves is due to Prof. E. C. Pickering. See *Journal*, Franklin Institute, vol. lvii. p. 55.

No. 1. All four tones in the same phase when starting.
,, 2. Tone 1 advanced $\frac{1}{4}$ vibration when starting.
,, 3. ,, 2 ,, ,, ,, ,,
,, 4. ,, 3 ,, ,, ,, ,,
,, 5. ,, 4 ,, ,, ,, ,,
,, 5a. ,, 1 ,, $\frac{1}{8}$,, ,,
,, 6. ,, 2 ,, ,, ,, ,,
,, 7. ,, 3 ,, ,, ,, ,,
,, 8. ,, 4 ,, ,, ,, ,,

Nos. 9 to 18 (inclusive) are combinations of the first three *odd* terms of the Harmonic Series:—

Ratios of vibration ... ... 1 : 3 : 5.
Amplitudes of vibration ... ... 1 $\frac{1}{3}$ $\frac{1}{5}$.

No. 9. All three tones in the same phase when starting.
,, 10. Tone 1 advanced $\frac{1}{8}$ vibration when starting.
,, 11. ,, ,, ,, $\frac{1}{4}$,, ,,
,, 12. ,, ,, ,, $\frac{3}{8}$,, ,,

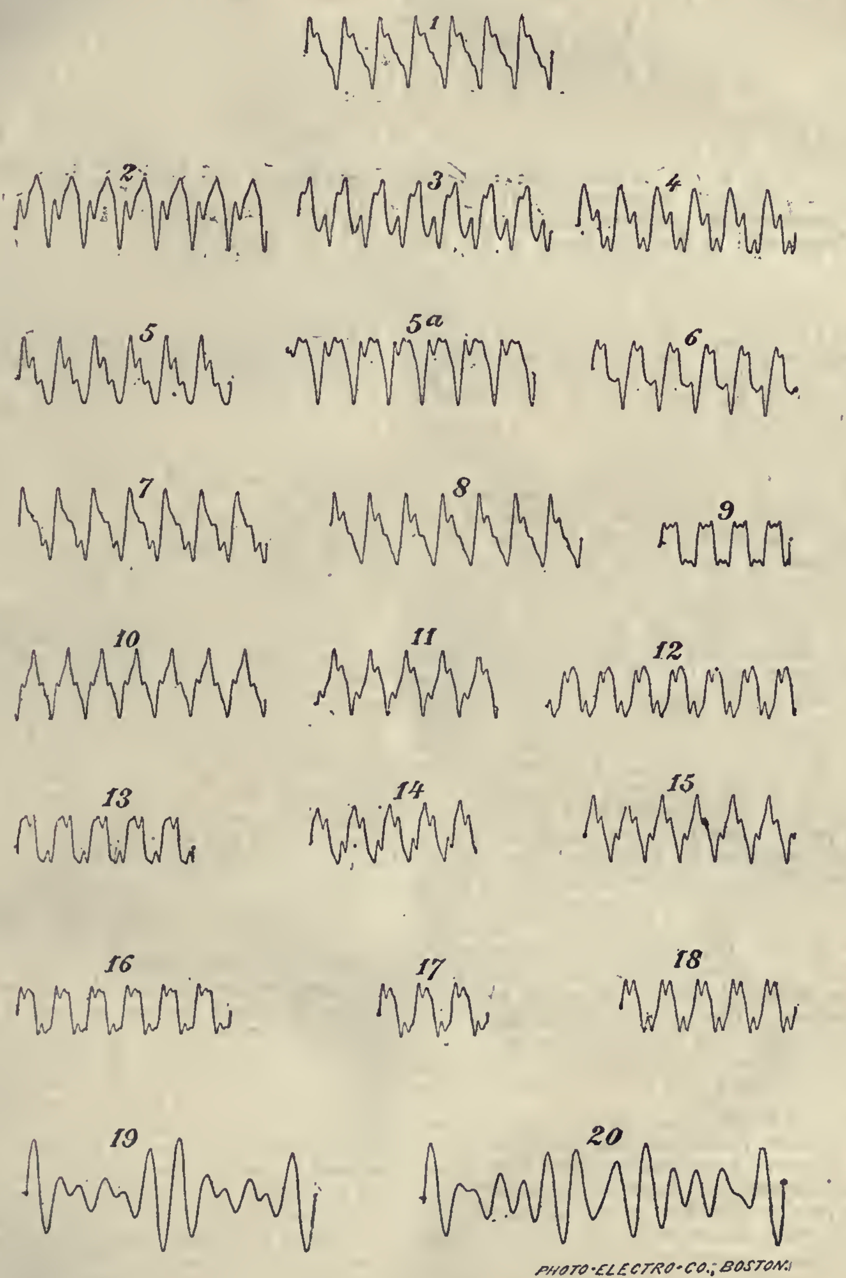


FIG. 2.

No. 13. Tone 3 advanced $\frac{1}{8}$ vibration when starting.
,, 14. ,, ,, ,, $\frac{1}{4}$,, ,,
,, 15. ,, ,, ,, $\frac{3}{8}$,, ,,
,, 16. ,, 5 ,, $\frac{1}{8}$,, ,,
,, 17. ,, ,, ,, $\frac{1}{4}$,, ,,
,, 18. ,, ,, ,, $\frac{3}{8}$,, ,,

Nos. 19 and 20 are combinations from the Diatonic Scale.
No. 19 shows the Common Chord, *Major*:—

Ratios of vibration ... ... 1 : $\frac{5}{4}$: $\frac{3}{2}$.

No. 20 shows the Common Chord, *Minor*:—

Ratio of vibration ... ... 1 : $\frac{6}{5}$: $\frac{3}{2}$.

In both the intensities of the component tones are equal, and their phases at starting identical.

BIOLOGICAL NOTES

Museum Pests in Entomological Collections.—Every record of successful contests with destroying agencies in museums will be of interest to collectors, and useful hints as well as valuable data in natural history may be derived from accounts of the animal species which appear in museums in widely separated localities. Very little information is as yet in print concerning museum pests in America, and Dr. H. A. Hagen has rendered a service to science by relating his experiences in the entomological collection of the Museum of Comparative Zoology, Cambridge, U.S. (*Proc.* Boston Soc. Nat. Hist., 1878, p. 56). He found *Dermestes lardarius* very abundant at first, but as it was easily recognisable it was soon extirpated. The excrements of the larva are large, granulous, and jet black. A much more dangerous foe is the larva of *Attagenus megatoma* (family Dermestidæ), having small globular ochreous excrements. Dr. Hagen was always able to find the crack in the box, through which the very thin and slender young larva entered. Anthrenus (same family) is represented by three species, of which the commonest in Europe (*A. museorum*) is very rare in Cambridge. *A. varius*, rare in Europe, is the most common pest in the collection, especially in new additions. *A. scrophulariæ*, the "carpet bug," has only been known to Dr. Hagen since 1872 in New England, and later still as a museum pest. It has since become very abundant and dangerous. The excrements consist of very fine light brown globules. *Ptinus fur*, so common in Europe, very seldom attacks the insects at Cambridge. *Tribolium ferrugineum* was imported from the East Indies. The flat body of the larva, as well as of the beetle, made it particularly fit to enter boxes through the smallest crack. It was got under by the aid of tobacco-smoke. The common clothes-moth was found very dangerous, and taught Dr. Hagen the lesson of placing every spreading-board at once in a tightly-closing box. Several years ago Dr. Hagen inclosed some clothes-moths with rotten insects in a glass-stoppered bottle, where they propagated year after year. In the fourth year the moths were noticed to be visibly smaller, and in the sixth most of them were scarcely half the ordinary size. But among them were always one or two of the normal stature. Nothing had been added to their food in these years. Two injurious species of Psocus, which are much attracted by paste and glue, do not infest Dr. Hagen's boxes, which are not lined with paper. Further, every spreading-board is carefully cleaned, and the cracks washed with alcohol before use. Acari have been easily kept out. Dr. Hagen strongly urges the entire separation of entomological rooms from those containing other preserved animals, especially mammals, birds, and skeletons. Having well-closing boxes, and never putting anything into the collection before it is safe, are the only satisfactory precautions. All other recommendations are but a poor substitute for bad boxes.

Effect of Light on Pelomyxa.—In a very low, amœba-like organism, *Pelomyxa palustris*, Herr Engelmann recently observed a remarkable action from sudden incidence of a moderate light (Pflüger's *Archiv für Physiologie*, Bd. xix. p. 1). Watched in the microscope this organism showed very slow movements, which, however, on shading the object, became much more lively. When the hand was removed, the granular mass in the interior became still, and the body contracted into a ball, as after an electric shock; this effect occurred within a few seconds. With continued moderate light, weak changes of form appeared again, with hardly perceptible locomotion. This experiment was several times repeated with equal success, and the results were especially notable in a dark room, into which diffuse daylight could be admitted. When, however, the room was illuminated, not suddenly, but gradually, the pelomyxa showed no effect.

The Ovule.—One of the most important of the recent contributions to the embryology of plants is, without question, Prof. Warming's memoir, "De l'Ovule" (*Annales des Scien. Nat.* sixe sér., Bot., tome v.). Commencing with a sketch of the views as to the origin of the ovule and nucleus, held in 1844 by Ad. Brongniart, which is in brief, "that there are two different origins for the ovule, the one to be found in the immense majority of flowering plants, in which the ovules make their appearance on the edges of the carpellary leaves, and represent the lobes or dentations of these leaves, the other confined to a very small number of plants (Primulaceæ, Myrsinaceæ, Theophrasteæ, and probably the Santalaceæ), in which the ovules correspond to so many distinct leaves carried on the prolongation of the floral axis. The nucleus is a production *de novo*, a cellular mamelon developed on the upper face of the lobe of the leaf and in the bottom of the cavity where it is formed." Cramer admits and confirms this view. Van Tieghem and Celâkovsky also agree to it, with this difference, that to them all the ovules appear as lobes of leaves, and that there are no independent ovular leaves. Warming, too, admits the theory. In every ovule there are, however, two parts essentially different, the funiculus and the teguments, which are, without doubt, of the nature of leaves, and the nucleus, which is a "new" creation—a veritable "sporangium," as Prantl says, a "sorus" composed of a single sporangium. Discarding for a moment the question whether ovular leaves exist or not (for example, in the yew), Warming doubts whether the funiculus should always be considered as foliar in certain cases. It is, perhaps, only a metablastome sprung from a leaf, but what is essential is that it is never a bud. In the memoir Warming looks at the question steadily from the point of view of histogenesis. The memoir consists of three chapters. On the early development of the leaf or ovular mamelon; on the genesis of the nucleus; and on the formation of the integuments of the mamelon. These chapters present a most masterly review of the whole question, one in which every due credit is given to the past and present workers in this field of research, and to none more than to the ingenious Slav botanist, Ladislao Celâkovsky. It is somewhat difficult to epitomise the author's conclusions, but he recognises that the morphological significance of an organ does not absolutely depend on its position. He demonstrates that the theory of Brongniart is the true and solely admissible one, and he reasons very conclusively against the views of Bronn, Eichler, and Strasburger, who would regard the ovule as a bud, while, in reality, as he says, "the ovule is the homologue of a sporangium."

Muscles of Crayfish.—While many observations of muscular contraction in vertebrate animals (especially the frog) are on record, the muscles of invertebrate animals have been little studied. M. Richet has recently directed his attention to these latter. From experiments with the myograph on the muscles of crayfish, he finds that the contraction of the muscle of a claw lasts nearly ten times as long as that of the caudal muscle (80 to 100 stimulations per second were needed to cause tetanus in the tail, while 2 to 4 sufficed for the claw). The contraction was not more retarded in one muscle than the other; with strong direct excitations, it is about a hundredth of a second; with weak it may be four or five hundredths. With the former stimulations applied to the ganglionic chain instead of directly, the total retardation is about 2·5 hundredths of a second. The muscle of the tail is very quickly exhausted, and this agrees with the fact that crayfish cannot swim any great distances. On the other hand, the muscle of a claw, stimulated by very closely following electric currents, is not exhausted. While the tetanus of the caudal muscle does not last more than twenty to thirty seconds, the muscle of the claw remains contracted nearly half an hour, and during the first five minutes the constriction of

the claw is stronger and stronger. This, too, accords with the habits of the crayfish, which will almost sooner die than let go its prey when seized. Thus between the two chief muscles of the crayfish there is a difference at least as considerable as between the striated and non-striated muscles of vertebrates.

SUSPENDED ANIMATION

THE statements in the *Times* of Monday, which, under the head of "A Wonderful Discovery," are copied from the *Brisbane Courier*, seem greatly to have astonished the reading public. To what extent the statements are true or untrue it is impossible to say. The whole may be a cleverly-written fiction, and certain of the words and names used seem, according to some readers, to suggest that view; but be this so or not, I wish to indicate that some part, at all events, of what is stated might be true, and is certainly within the range of possibility.

At once let me state that the discovery, so called, which is described in the communication under notice, is not in principle new. On the subject of suspension of animation I have myself been making experimental inquiries for twenty-five years at least, and have communicated to the scientific world many essays, lectures, and demonstrations relating to it. I have twice read papers bearing on this inquiry to the Royal Society, once to the British Association for the Advancement of Science, two or three times in my lectures on Experimental and Practical Medicine, and published one in NATURE. In respect to the particular point of the preservation of animal bodies for food, I dwelt on this topic in the lectures delivered before the Society of Arts in April and May of last year, 1878, explaining very definitely that the course of research in the direction of preservation must ultimately lead to a process by which we should keep the structures of animals in a form of suspended molecular life.

Let me next point out what, by experiment, is known as to the possibility of suspending animal life.

If an animal perfectly free from disease be subjected to the action of some chemical agents or physical agencies which have the property of reducing to the extremest limit the motor forces of the body, the muscular irritability, and the nervous stimulus to muscular action, and if the suspension of the muscular irritability and of the nervous excitation be made at once and equally, the body even of a warm-blooded animal may be brought down to a condition so closely resembling death, that the most careful examination may fail to detect any signs of life. I have shown in a Croonian lecture that there are three degrees of muscular irritability to which I have given the names of active efficient, passive efficient, and negative. The first of these states is represented in the ordinary living muscle in which the heart is working at full tension, and all parts of the body are thoroughly supplied with blood, with perfection of consciousness in waking hours, and, in a word, full life. The second of these states is represented in suspended animation, in which the heart is working regularly, but at low tension, supplying the muscles and other parts with sufficient blood to sustain the molecular life, but no more. The third of these states is represented when there is no motion whatever of blood through the body, as in an animal entirely frozen.

The second stage, the stage of passive efficiency, is that in which animation is usually suspended. The condition is a close semblance to the third stage, but differs from it in that under favouring circumstances the whole of the phenomena of the active efficient stage may be perfectly resumed, the heart suddenly enlarging in volume, from its filling with blood, and reanimating the whole organism by the force of its renewed stroke, in full tension.

So far as we have yet proceeded, the whole phenomena of restoration from death are accomplished during this stage. To those who are not accustomed to see them, they are no doubt very wonderful, looking like veritable restorations from death. They surprise even medical men the first time they are witnessed by them.

At the meeting of the British Medical Association at Leeds, a member of the Association was showing to a large audience the action of nitrous oxide gas, using a rabbit as the subject of his demonstration. The animal was removed from the narcotising chamber a little too late, for it had ceased to breathe, and it was placed on the table, to all appearances dead. At this stage I went to the table, and by use of a small pair of double-acting bellows restored respiration. In about four minutes there was revival of active irritability in the abdominal muscles, and two minutes later the animal leaped again into life, as if it had merely been asleep. There was nothing remarkable in the fact, but it excited, even in so cultivated an audience as was then present, the liveliest surprise.

The time during which an animal body may be capable of re-animation from the state of passive efficiency depends altogether on one circumstance, viz., whether the blood, the muscular fluid, and the nervous fluid remain, in a condition which I have defined in another essay as the aqueous condition, or whether these fluids have become pectous. If the fluids remain in the aqueous state, the period during which life may be restored is left undefined. It may be a very long period, including weeks, and possibly months, granting that decomposition of the tissues is not established, and even after a limited process of decomposition, there may be renewal of life in cold-blooded animals. But if pectous change begins in any one of the structures I have named, it extends like a crystallisation quickly through all the structures, and thereupon recovery is impossible, for the change in one of the parts is sufficient to prevent the restoration of all. Thus the heart may be beating, but the blood being pectous it beats in vain; or the heart may beat and the blood may flow, but the voluntary muscles being pectous, the beating is in vain; or the heart may beat, the blood may flow, and the muscles may remain in the aqueous condition, but the nerves being pectous the circulating action is in vain; or sometimes the heart may come to rest and the other parts may remain susceptible, but the motion of the heart and blood not being present to quicken them into activity, their life is in vain.

The problem physiologically before us is as follows:—Can the second or passive efficient stage of life be by any artificial methods secured, so that all the vital parts may be held in suspended animation, working at the lowest possible expenditure of vital power?

Experimental research and experience alike show the certain possibility of temporarily producing this state. Both show that there are agents and agencies by which life may be reduced to the low ebb necessary for suspension of active life, and at the same time the aqueous conditions of the colloidal fluids may be maintained. Cold is the first and most efficient of these agencies. The blood and the colloidal animal fluids derived from it are all held in the aqueous condition of colloidal matter by exposure to cold at freezing-point. At this same point all vital acts, excepting, perhaps, the motion of the heart, may be temporarily arrested in an animal, and then some animals may continue apparently dead for long intervals of time, and may yet return to life under conditions favourable to recovery.

In one of my lectures on death from cold, which I delivered in the winter session of 1867, some fish, which, during a hard frost, had been frozen in a tank at Newcastle-on-Tyne, were sent up to me by rail. They were produced in the completely frozen state at the lecture, and by careful thawing many of them were restored to perfect life. At my Croonian lecture on muscular irritability after systemic death, a similar fact was illustrated from frogs.

There seems in cold-blooded animals so circumstanced to be no recognisable limit of time after which they may not recover, but there is much skill required in promoting the recovery. If in thawing them the utmost care be not taken to thaw gradually, and at a temperature always below the natural living temperature of the animal, the fluids of the animal will pass from the frozen state through the aqueous into the pectous so rapidly that death from pectous change will be pronounced without perceiving any intermediate or life-stage at all. In warm-blooded animals it is extremely difficult to restore animation after suspension of life by cold, owing to the fact that in their more complex and differently-shielded organs, it is next to impossible to thaw equally and simultaneously all the colloidal fluids. In very young animals it can be done. Young kittens, a day or two old, that have been drowned in ice cold water, will recover after two hours' immersion almost to a certainty, if brought into a dry air at a temperature of 98° F. The gentlest motion of the body will be sufficient to re-start the respiration and therewith the life.

The nearest approach we see naturally to this state is in hybernating animals. In them the effects of cold in the season for hybernation and the recovery from the torpor are seen even in matured and old animals. In hybernation, however, there is not produced the complete stage of passive efficiency. There is in them a slow respiration and a low stage of active efficiency of circulation. The hybernating animal sleeps only; and while sleeping it consumes or wastes, and, if the cold be prolonged, it may die from wasting. From the sleep of hybernation also the animal can be roused by the common methods used for waking a sleeper, so that animation is not positively suspended.

Returning to the extreme effects of cold on animal bodies, it is hard to say whether an animal like a fish, frozen equally through all its structures, is actually dead, in the strict sense of the word, seeing that if it be uniformly and equally thawed it may recover from a perfect glacial state. In like manner it may be doubted whether a healthy warm-blooded animal, suddenly and equally frozen through all its parts, is dead, although it is not recoverable, because, in the very act of trying to restore it, some inequality in the direction is almost sure to determine a fatal issue owing to the transition of some vital centre into the pectous state of colloidal matter. I do not, consequently, see that cold can be of itself and alone utilized for maintaining suspended animation in the larger warm-blooded animals of full growth. At the same time cold will, for a long time, maintain, ready for motion, active organs locally subjected to it. Even after death this effect of it may be locally demonstrated, and has sometimes been so demonstrated to the wonder of the world. On January 17, in the year 1803, Aldini, the nephew of Galvani, created the greatest astonishment in London by a series of experiments which he conducted on a malefactor, twenty-six years old, named John Forster, who was executed at Newgate, and whose body, an hour after execution, was delivered over to Mr. Keate, Master of the College of Surgeons, for research. The body had been exposed for an hour to an atmosphere two degrees below freezing-point, and from that cause, though Aldini does not seem to have recognized the fact, the voluntary muscles retained their irritability to such a degree that when Aldini began to pass voltaic currents through the body some of the bystanders seem to have concluded that the unfortunate malefactor had come again to life. It is significant also that Aldini, in his report, says that his object was not to produce re-animation, but to obtain a practical knowledge how far galvanism might be employed as an auxiliary to revive persons who were accidently suffocated, as though he himself were in some doubt.

In repeating Aldini's experiments on lower animals that had passed into death under chloroform, with the view of determining what is the best treatment for those human beings who sink under chloroform and other anæsthetics, I failed altogether to obtain the same results when the temperature of the day was high. Noticing this, I experimented at or below freezing-point, and then found that both by the electrical discharge and by injection of water heated to 130° F. into the muscles through the arteries, active muscular movements could be produced in warm-blooded animals many hours after death. Thus, for lecture experiment I have removed one muscle from the body of an animal that had slept to death from chloroform, and, putting the muscle in a glass tube surrounded with ice and salt, I have kept it for several days in a condition for its making a final muscular contraction, and, by gently thawing it, have made it, in the act of final contraction, do some mechanical work, such as moving a long needle balanced on the face of a dial, or discharging a pistol.

In muscles so removed from the body and preserved ready for motion, there is, however, only one final act. For, as the blood and nervous supply are both cut off from it, there is nothing left in it but the reserve something that was fixed by the cold; but I do not see any reason why this should not be maintained in reservation for weeks or months, as easily as for days, in a fixed cold atmosphere.

Besides cold there are other agencies which hold the colloidal fluids in the aqueous state, and which, while they suspend the motor function, suspend without necessarily destroying life. Several agents of this class have been discovered.

Mandragora.—The first known of these suspending agents was mandragora. This was known as far back as Dioscorides. Dioscorides states that this vegetable substance may be administered in such a manner that the signs of active life may disappear, and sensibility be so far destroyed that the physician or surgeon may operate on the temporarily insensible without producing pain. The suspension of life from mandragora may extend over some hours, and the use of the agent probably was continued until the twelfth or thirteenth century. From the action of it doubtless comes the Shakespearian legend of Juliet. In modern times I have made the wine of mandragora, and found that it has the power originally attributed to it of suspending without destroying active life. The wine from it was the morion of the ancients, the fluid probably that was used by the Jewish women in the times of the Sanhedrim to destroy the sufferings of those who were under torture, and sometimes, perchance, to deceive the executioner and prevent the deadliness of his task.

The plant from which morion was originally made, the *Atropa belladonna* (deadly nightshade), has, in this country, similar properties to its ally the *Atropa mandragora.* In 1851 I attended at Mortlake two children who were poisoned for a time from eating the berries and chewing the leaves of the nightshade which they had gathered near to Richmond. The children were brought home insensible, and they lay in a condition of suspended life for seven hours, the greatest care being required to detect either the respiration or the movements of the heart. They nevertheless recovered.

Nitrite of Amyl.—In my original researches on the nitrite of amyl, one of the observations which most surprised me was the power of this agent to suspend animation. In the report I made to the British Association in 1864 on this subject, I showed that the life of the frog might be suspended for the period of nine days, and yet recovery to full and vigorous life might follow; that the same power of suspension, in a lesser degree, could be produced in warm-blooded animals, and that the heart of a warm-blooded animal would contract for the period of eighteen

hours after apparent death. The action of the nitrite of amyl in causing suspended animation seemed to be like cold. It prevented the pectous change of colloidal matter, and so prevented rigor mortis, coagulation of blood, and solidification of nervous centres and cords. So long as this change was suspended return of vital function was possible. When the pectous change occurred, all was over, and resolution into new forms of matter by putrefaction was the result.

From the analogy of some of these symptoms from nitrite of amyl with the symptoms of the disease called catalepsy, I have ventured to suggest that, under some abnormal conditions, the human body itself, in its own chemistry, may produce an agent which causes the suspended life observed during the cataleptic condition.

Woorali in a similar manner suspends vital function; but as the influence of this agent has been more frequently under observation from other physiologists, I leave it with this mention of it.

Chloral Hydrate has many of the properties of the other substances named above in its power of suspending life. At the meeting of the British Association at Exeter, at which I made the earliest report in this country of Liebreich's remarkable discoveries, some pigeons, which had been put to sleep by the needle-injection of a large dose of chloral, fell into such complete resemblance of death, that they passed among an audience containing many physiologists and other men of science for dead. For my own part I could detect no sign of life in them, and they were laid in one of the out-offices of the museum of the infirmary as dead. In this condition they were left late at night, but in the following morning they were found alive and as well as if nothing hurtful had happened to them.

Cyanogens. — Cyanogen gas and hydrocyanic acid, deadly poisons as they are, have the power in a singular degree of suspending animation. Combined with a sufficient degree of cold to prevent their evaporation from the body, their suspending power is of the most definite kind. In the laboratory of a large drug establishment a cat, by request of its owner, was killed, as it was assumed, instantaneously and painlessly by a large dose of Scheele's acid. The animal appeared to die without a pang, and presenting every appearance of death was laid in a sink to be removed on the next morning. At night the animal was lying still in form of death in the tank beneath a tap. In the morning it was found alive and well, but with the fur wet from the dropping of water from the tap. This fact was communicated to me by the eminent chemist under whose direct observation it occurred, in corroboration of an observation of mine similar in character.

Alcohol is another substance which holds the vital functions in suspense for long periods of time, the muscles retaining their excitability. In animals killed by alcohol in combination with cold, two influences which act powerfully together in the same direction, I found the muscular excitability could be retained at freezing-point for several hours even in birds. A remarkable similar experience, which I have elsewhere recorded, was obtained in the case of an intoxicated man who, while on the ice at the Welsh Harp lake, fell into the water through a breakage in the ice, and who for more than fifteen minutes was completely immersed. This man was extricated to all appearances dead, but under artificial respiration, carried out by my friend Dr. Belgrave, of Hendon, he was restored to consciousness and lived for several hours.

Oxygen.—It is not a little singular that pure oxygen gas possesses the power of suspending life, at all events in muscular fibre, when it is aided by condensation produced by cold; but I am on new ground here, with which I am not so conversant at present as I hope to be.

I have now shown as briefly as was possible that much is known in the world of science in respect to suspension of animal life by artificial means. It will be seen that cold as well as various chemical agents has this power; and it is worthy of note that cold, together with the agents named, is antiseptic, as though whatever suspended living action, suspended also by some necessity or correlative influence the process of putrefactive change. Hence the influence I drew in my lecture at the Society of Arts, that it was within the range of experiment to preserve the structures of dead animals in a form of suspended molecular life.

If the experiments reported from Brisbane be reliable it is clear, I think, that what has been done has been effected by the combination of one of the chemical agents above named, or of a similar agent, in combination with cold, the efficiency of which combination we have seen in many of the experimental facts referred to above. The only question that exists as of moment is, not whether a new principle has been developed, but whether, in matter of detail, a new product has been discovered which, better than any of the agents we already possess, destroys and suspends animation. In organic chemistry, there are, I doubt not, hundreds of substances which, like mandragora and nitrite of amyl, would suspend the vital process, and it may be that a new experimenter has met with such an agent. It is not incredible indeed that the Indian Fakirs possess a vegetable extract or essence which possesses the same power, and by means of which they perform their as yet unexplained feat of prolonged living burial: but I confess, on reading the Australian narrative, there is nothing suggested by it to my mind that might not be produced by agents already known. Making allowance for what is clearly a very enthusiastic description, there is nothing in an experiment related as made on a dog that might not have been produced by the subcutaneous injection of hydrate of chloral; neither is there anything in other experiments that might not follow from the injection of chloral or woorali in a cold atmosphere. At the same time it is not also unreasonable to infer that a new product has been found which surpasses any we possess, and suspends animation for a longer period. My faith is most shaken first by the statement that the agent referred to is a secret, for men of true science know no such word; secondly, that the experimenter has himself to go to America to procure more supplies of his agents; and thirdly, that he requires two agents, one of which is antidotal to the other. I can understand the production of a definite effect from a single; and others as well as myself have made out a great many facts respecting the antagonism of one agent by another. But in our researches on antagonistic physiological substances we require the agencies of absorption and circulation of the antidote, and how in a body bereft of motion and practically dead such absorption can take place I am unable to divine.

But even should the description given by the Australian journalist prove overdrawn or imaginative, I am not sorry it has appeared, since it has afforded a reason for relating in a plain and faithful manner to what actual extent human knowledge has been advanced by experiment on the subject under consideration. This duty, though it be but preliminary, is important as an introduction to those great events which in the future are sure to come from the positive results that have already been secured, and for which the world should be prepared, without anxiety or amazement.

BENJAMIN WARD RICHARDSON

NOTES

THE death is announced of William Froude, F.R.S., a name familiar to our readers in connection with experiments on wave-resistances and the form of ships. Mr. Froude, who had long

been in weak health, left England in November last year, in H.M.S. *Boadicea*, for a holiday cruise to the Cape, and he died from dysentery on the 4th inst., at Simon's Town. We defer further notice of Mr. Froude's life and work till next week.

ANOTHER advance of the greatest importance has been made by the U.S. Signal Service in the department of practical meteorology. In the *Daily Graphic* for May 9, published in the afternoon at New York, is a map of the principal portion of the United States, with the weather conditions of the same morning. The map gives in distinct outline the lines of equal atmospheric pressure and of the temperatures over the United States, with the prevailing directions of the wind and the general weather conditions. By the aid of this map, which it is proposed to make a regular feature of the *Graphic*, any one can form a fair idea of the weather changes in any specified locality for some days to come. The observations indicated in the map were made at all the signal stations of the U.S. Government at thirty-five minutes past seven on the morning of the 9th, and having been collated at the central office in Washington at nine o'clock, were transmitted specially by telegraph to the *Graphic* by ten o'clock. All the details of the map have been carefully considered and are easily intelligible to any reader after a little study. The importance of this step cannot be overrated, and we only wish we saw the *Pall Mall* and other evening papers following the excellent example of their New York contemporary.

PROF. ASAPH HALL has been elected a corresponding member by the Paris Academy of Science to fill the place in the astronomical section vacant by the death of M. Santini.

THERE is being erected at Meudon a large construction in connection with the Physical Observatory, where a large refracting telescope will be fitted up. During the time that the works are being carried on M. Janssen continues his solar photography on the site where his instruments have been established, in a part of the old Château. The diameter of the photographs obtained by direct operation is now 50 centimetres, and the time of exposure to solar radiation diminished to $\frac{1}{3000}$th of a second. The interval of time between two successive operations has been reduced to two minutes by the application of the revolver system. Although the two images may represent the surface of the sun at periods so near each other, M. Janssen has discovered that there is always a striking difference in the two images. It must be considered as proved by these observations that no spot on the sun can be regarded as being in a state of quiescence, even during so short a period, and that the changes are important enough to be perceived at the distance of the sun viewed from the earth, although the smallest spot observable must be regarded as having a surface larger than the whole of France, a second of arc on the sun being equal to the distance between Paris and Marseilles.

ADMIRAL MOUCHEZ has almost completed his museum of astronomy in one of the rooms of the Paris Observatory. Exclusive of the portraits of Bouvard, Arago, Leverrier, Cassini, and other directors, a series of the principal celestial objects has been painted on the walls by talented artists. In the middle is a glass case in which a number of instruments used by astronomers of former ages are exhibited. M. Mouchez intends to publish a monthly periodical, which will be called *Journal d'Astronomie*. A part will be reserved for the original communications of the astronomers of the Paris Observatory, and part devoted to reviewing foreign astronomical periodicals.

THE Paris Anthropological Society has recently awarded prizes as follows:—The Godard Prize (500 francs and a silver-gilt medal) to Dr. Le Bon, for a work on the development of the cranium according to civilisation, age, and sex; two honourable mentions (with bronze medals) to M. Ujfalvy, for the first volume of his "Journey in Turkestan," and M. Zaborowski, for his "Manual of Prehistoric Archæology;" the prize in French Ethnology to Dr. Chervin, for his statistical works; and honourable mention to M. Rivière for his prehistoric researches.

SIR WILLIAM THOMSON gave some valuable evidence on Friday before the Select Committee engaged in considering the subject of the electric light. He said that whereas one-horse-power of energy would only produce 12-candle gas light, it might produce 2,400-candle electric light. "The upshot of the experiments made at the factory of Messrs. Siemens, at Woolwich, and at the natural philosophy class of the University of Edinburgh, was that, allowing the practical estimate of one-horse-power applied in driving the engine, it had produced 1,200 candles of actual visible electric light, half the gross energy going to produce the light while the other half was lost in heating the machine and the wires. As the electric light was such an economical producer he anticipated that it had a great and immediate future before it. He believed before long it would be used in every case where a fixed light was required, whether in large rooms or small ones—even in passages and staircases of private dwellings. There was immense promise in the actual work carried out by practical men in the present day. There was a prodigiously greater economy in the transmission of mechanical force into energy in the case of the electric light than in the case of gas. With regard to regulators for the electric light, he had seen one the previous day—the Siemens regulator—which gave a steady, pure, and quiet light. The electric light was especially adapted for being placed high where it illuminated a wide area. It might be put upon an iron pole raised 60 feet high, or the old French plan of swinging a lamp on a wire from one side of the street to the other might be followed with advantage. Such a plan would be useful in doing away with the necessity for opal globes, which destroyed a large quantity of the illuminating quality of the light. Indeed, he was surprised that these globes had ever been used, wasting as they did 50 or 60 per cent. of the illuminating power. He considered that the advantages of using the electric light within buildings would be very great, because of the small effect it would have when compared with gas in heating and vitiating the atmosphere. In the case of electricity, the waves of light only became converted into sensible heat, not in the air, but on the ceiling or walls and floor of the room after they had done their work. With regard to the subdivision of the light, according to practical experiments, if the same amount of energy that was used in producing one large light was employed in producing ten feebler lights, none of those lights gave one-tenth of the amount of illumination of the one large concentrated light. Still there was nothing mathematically impossible in the matter, and it was quite possible that a plan of subdivision might be found by which the ten feebler lights would give a sum of illumination equal to that of the one larger light. He considered that the electric light as now developed was fit for use in large rooms. He was also of opinion that a great deal of natural energy which was now lost might be advantageously applied in the future to lighting and manufactures. There was a deal of energy in waterfalls. In the future, no doubt, such falls as the Falls of Niagara would be extensively used—indeed, he believed the Falls of Niagara would in the future be used for the production of light and mechanical power over a large area of North America. The electricity produced by them might be advantageously conducted for hundreds of miles, and the manufactories of whole towns might be set in motion by it. Powerful copper conductors would have to be used—conductors of a tubular form

with water flowing through them to keep them cool. There would be no limit to the application of the electricity as a motive power; it might do all the work that could be done by steam-engines of the most powerful description. It seemed to him that legislation, in the interests of the nation and in the interests of mankind, should remove as far as possible all obstacles such as those arising from vested interests, and should encourage inventors to the utmost. As to the use of electricity by means of the Falls of Niagara, his idea was to drive dynamic engines by water power in the neighbourhood of the Falls and then to have conductors to transmit the force to the places where illumination or the development of mechanical power was wanted. There would be no danger of terrible effects being brought about accidentally by the use of such a terrific power, because the currents employed would be continuous and not alternating." This may be called a fanatical view of the electric light.

On Tuesday night the electric light was put to rather a novel use, and one well calculated to test its practical and especially artistic value. At the Horticultural Society's *conversazione*, various forms of the light were adjusted so as to illuminate the magnificent array of fruit and flowers of all kinds and colours, with, we believe, complete success, the only drawback being the wretched state of the weather. Still it was clearly shown how admirably adapted this form of light is to any purpose in which it is essential that colours should be shown almost *au naturel*.

On Monday evening Mr. J. F. Bateman, president of the Institution of Civil Engineers, received at a *conversazione* at the South Kensington Museum a large assemblage of distinguished representatives of science, literature, and art. The long galleries of models of machinery and naval architecture were thronged with eight or nine hundred visitors, and brilliantly illuminated with electric lights, presenting a scene of exceptional brilliancy. The electric lights employed were of many different systems, including the Jablochkoff candle, Siemens's apparatus, that of the Electric Lighting Company, fitted with Wilde's automatic carbon holders, Higgins's incandescent light, and many others, displaying both covered and naked lights. Many noteworthy models of machinery had been specially added for the occasion by well-known engineers. Among these new contributions, which attracted a constant succession of interested groups of visitors, were in particular a working model of the writing telegraph of Mr. Cowper, and Dr. W. H. Coffin's modification of M. Trouvé's minute electric lamp for surgical use. These, however, were only two among the numberless objects claiming attention in an exhibition full of interest and instruction.

As usual the Geologists' Association have arranged an excursion for Whit Monday and Tuesday. This year it is to Bath, under the direction of Messrs. Charles Moore and W. H. Huddleston.

Mount Etna is in a state of eruption; on the 26th an opening occurred on the northern side, from which issued dense volumes of smoke and flames.

The administration of the scientific exhibition to be held at Paris from July to November next, is desirous to establish a special section of electricity if agreeable to intending exhibitors, consequently all the electricians who have subscribed already are requested to state their opinion.

A Zoological Society of New South Wales has been formed at Sydney; one of its chief objects is the acclimatisation of foreign animals.

The Midland Union of Natural History Societies held its second annual meeting at Leicester on Tuesday and Wednesday, May 20 and 21, under the presidency of Mr. Geo. Stevenson, who delivered an address to the large body of members from all parts of the Midland Counties, who met together in the Town Hall, Leicester. He pointed out how the usefulness of the Union might be best developed, and urged the members to co-operate together in definite efforts to solve some of the many problems of local and scientific interest. The first work of the kind which some of the societies had already taken up was an examination of the glacial drift deposits of the Midland districts, a scheme for which had been published by Mr. W. J. Harrison, F.G.S., one of the secretaries of the Union, in the *Midland Naturalist*. In due time the results of these efforts would be made public, and from what was already known of the labours of the inquirers some valuable information will be published. The Union now includes twenty-four societies, and there were representatives present from most of them. The societies in the Union (numbering nearly 3,000 members) are the following:—Birmingham Natural History and Microscopical Society, Birmingham Philosophical Society, Birmingham and Midland Institute Scientific Society, Birmingham School Natural History Society, Burton-upon-Trent Natural History and Archæological Society, Caradoc Field Club, Cheltenham Natural Science Society, Derbyshire Naturalists' Society, Dudley and Midland Geological and Scientific Society and Field Club, Evesham Field Naturalists' Club, Leicester Literary and Philosophical Society, Northampton Naturalists' Society, Nottingham Literary and Philosophical Society, Nottingham Naturalists' Society, Rugby School Natural History Society, Oswestry and Welshpool Naturalists' Field Club, Peterborough Natural History and Scientific Society, Severn Valley Naturalists' Field Club, Shropshire Archæological and Natural History Society, Small Heath Literary and Scientific Society, Stroud Natural History Society, Tamworth Natural History, Geological, and Antiquarian Society, Woolhope Naturalists' Field Club. In the evening of the first day a most successful *conversazione* and exhibition of microscopes, scientific apparatus, experiments, &c., was held in the Leicester Museum buildings. On Wednesday about 200 members made an excursion to Charnwood Forest, which was divided into two sections—one, geological, under the guidance of Mr. W. J. Harrison, F.G.S., and the other botanical, of which Mr. F. T. Mott, F.R.G.S., was the leader. The annual meeting in 1880 was fixed to be held at Northampton under the auspices of the Northampton Naturalists' Society; Mr. Edward W. Badger (Birmingham), and Mr. G. C. Druce (Northampton) were elected hon. secretaries for the year; and Mr. H. E. Forrest (Birmingham) assistant hon. secretary.

We are pleased to see that a Scientific and Historical Society has been formed at Launceston, under the presidency of the Rev. G. H. Hopkins. From the opening address of the president it is evident that the Society has formed a correct idea of what should be the work of a local society, and we trust that the members will work energetically together to carry out the programme thus sketched. The district covered by the Society may be said to include North-east Cornwall and North-west Devon between Dartmoor and Bodmin Moor, with the sea-coast on the north. The sections are archæology, botany, meteorology, zoology, and geology, and in all departments the district ought to yield rich fruits. The Society seems to have made a good start, and we shall watch its progress with interest. We trust it will enlist a large proportion of real workers.

An interesting experiment was made on May 22 before M. Tresca, the sub-director of the Paris Conservatoire des Arts et Métiers. M. Chretien, an engineer of Paris, has constructed a set of two locomotive ploughs worked by rope traction according to the Fowler system. But instead of using steam power, M. Chretien has employed the electric current generated by a Gramme machine, and a stationary steam-engine. It has been

determined by M. Tresca that one-half of the motive power generated by steam was really transferred to a distance of above one kilometre from the furnace. The motive power which has been utilised for farming land can be employed for excavating, or executing any description of work.

THE carrier-pigeon service is now in full operation in France, and has been placed under the direction of the head of aërial communication. The number of birds fed by the Government is 6,000. These pigeons are located in Paris and twelve other large fortified towns. A number of soldiers and officers have been taught the art of pigeon breeding, and carriers are constantly sent from place to place. The Minister of Public Instruction and the Minister of Agriculture have established prizes for pigeon races.

THE strong interest recently awakened in Owens College, Manchester, has been shown in a desire on the part of some of his admirers to do honour to the founder. This has taken the form of a memorial window, which is to be erected in St. John's Church, near the College; and the donors have commissioned Mr. W. G. Taylor, of Berners Street, to carry out the work, which will be completed towards the end of next month. At the foot of the three lights are the words "Ars, Religio, Scientia," symbolised by subjects illustrating music, charity, and astronomy. The arms of the College and of John Owens occupy the bases of the side lights.

ONE of the new Cardinals, Haynald, Archbishop of Kalocsa in Hungary, is eminent as a botanist, as we learn from the *Gardeners' Chronicle*, and is probably the first botanist who has ever held so exalted a rank.

THE Sanitary Institute of Great Britain has issued a very satisfactory second Annual Report.

WE note that Dr. W. G. Farlow, for the past five years Assistant Professor of Botany at the Bussey Institution, Harvard University, has been appointed Professor of Cryptogamic Botany in the University proper. This is the first professorship in this important and difficult department established in the United States. The laboratory for instruction and research in the lower cryptogamia is now established at Cambridge.

FOR the schools of California, "A Popular Californian Flora; or Manual of Botany for Beginners," has (in part) been lately published by Mr. Volney Rattan, teacher in the Girl's High School, San Francisco. A second part will complete it. It is restricted to plants of the San Francisco region, extending north to Mendocino County, south to Monterey, and west to the foot hills of the Sierra Nevada.

"CINCHONA CULTURE IN BRITISH INDIA" is the title of a useful pamphlet by Surgeon-Major G. Bidie, Superintendent of the Madras Central Museum, being one of the Museum Popular Lectures of the season 1878-9.—We have received a separate copy of a paper "On Pollen," by Mr. M. S. Evans, read before the Natal Microscopical Society on November 18 last.—The Fifth Report of the Boulder Committee of the Royal Society of Edinburgh contains notes on a considerable number of boulders in Scotland, with numerous illustrations.—West, Newman, and Co. publish a monograph by Mr. P. H. Gosse, F.R.S., on "The Great Atlas Moth of Asia (*Attacus atlas*, Linn.)," with a coloured plate of its transformations.—We have received a very favourable Report of the Condition and Progress of the Davenport (U.S.) Academy of Natural Sciences, which is now in its eleventh year, and doing good and varied work.—"On the Lancashire Coal Fields," is the title of a paper by Mr. C. E. De Rance, reprinted from the *Proceedings* of the Geologists' Association.—A fourth edition of Bloxam's "Laboratory Teaching" has been issued by Messrs. Churchill. The most important alteration is the introduction of the formulæ representing the various chemical compounds described in the notes in the tables.

THE additions to the Zoological Society's Gardens during the past week include a Grey-cheeked Monkey (*Cercocebus albigena*) from West Africa, presented by Mr. Robert Surry; a Patagonian Sea Lion (*Otaria jubata*) from the Falkland Islands, presented by Mr. F. E. Cobb; a Roseate Cockatoo (*Cacatua roseicapilla*) from Australia, presented by Mr. Head; a Blue-winged Green Bulbul (*Phyllornis hardwickii*) from India, presented by Mr. A. Jamrach; two Horned Lizards (*Phrynosoma cornutum*) from Texas, presented by Mr. E. Loder; a Javan Fish Owl (*Ketupa javanensis*) from Java, a Ceram Lory (*Lorius garrulus*) from Moluccas, three Abyssinian Guinea Fowls (*Numida ptilorhyncha*) from Abyssinia, a Nicobar Pigeon (*Calœnas nicobarica*) from the Indian Archipelago, a Victoria Crowned Pigeon (*Goura victoriæ*) from the Island of Jobie, a Mace's Sea Eagle (*Haliaëtus leucoryphus*) from India, two Black-tailed Godwits (*Limosa melanura*) twelve Common Widgeons (*Mareca penelope*), European, purchased; a Cheetah (*Felis jubata*) from Africa, two Bactrian Camels (*Camelus bactrianus*) from Central Asia, deposited; two Black Swans (*Cygnus atratus*) from Australia, received in exchange; two Chinchillas (*Chinchilla lanigera*), a Black-necked Swan (*Cygnus nigricollis*), bred in the Gardens.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

FROM No. 6 of the *University College School Magazine* (London) we see that the editor's post is not altogether a pleasant one, though the number is very creditable. The U.C.S. Scientific Society seems in a healthy condition. In connection therewith we notice that a series of sixteen lectures are to be given during this term on the Science of Daily Life. We trust they will be well attended.

FROM the Report for 1878 of the Rugby School Natural History Society we learn that it is fairly flourishing. The entomological, geological, and archæological sections have been vigorous, though the workers in each are fewer than they should be. Altogether there does not seem to us to be that hearty interest in the Society among the boys that conduces to complete success; all the more reason, therefore, for the real working members keeping up their work with unflagging zeal and doing their best to enlist the sympathy and help of the indifferent. A satisfactory observatory Report from Mr. Seabroke is appended.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 1.—"On the Origin of the Parallel Roads of Lochaber, and their bearing on other Phenomena of the Glacial Period." By Joseph Prestwich, M.A., F.R.S., F.G.S., &c., Professor of Geology in the University of Oxford.

Of the various hypotheses that have been brought forward since the time of Macculloch and Dick-Lauder in 1818, to account for the origin of the Parallel Roads of Glen Roy, the one so ably propounded by Mr. Jamieson, in 1863, has been most generally received and adopted.[1] It is a modification of the views originally expressed by Agassiz, to the effect that the barriers of the lakes—to the shore action of which both the above-named geologists attributed the "roads," but were at a loss to account both for the formation and removal of barriers—had been formed during the glacial period by glaciers issuing from Glen Treig and Glen Arkaig, supplemented by others from Ben Nevis. The subsequent determination, by the Scotch geologists, of an intermediate milder period succeeded by a second cold period, led Mr. Jamieson, with whom the pre-glacial and glacial deposits of Scotland had been a subject of especial investigation, to conclude that the extension of these two places took place during the second cold period, which he thinks was of little less intensity than the first, and that, while the glacier from

[1] Darwin's well-known paper, in which he considered the "roads" to be old sea-beaches, appeared in the Philosophical *Transactions* for 1839. This marine hypothesis was afterwards earnestly advocated by R. Chambers and Prof. Nicol, but is no longer held by its distinguished author.

Glen Arkaig blocked up Glen Gluoy, the glacier from Glen Treig formed a barrier to Glen Roy.

The "roads" were, he considers, formed by long-continued shore action at each successive level of the lake, that level being determined by the height of the cols over which the lake waters escaped.

To these views it has been objected, by Mr. Milne-Holme and others, that it is difficult to conceive the glens to the north of the Spean Valley to have been filled with water while at the same time those on the south were filled with ice, and he advocates a detrital barrier formed of clay, sand, and gravel, by marine origin, when the sea stood some 3,000 feet higher than at present.

Prof. Nicol, also, has pointed out that, had lakes existed in Glen Gluoy, Glen Roy, and Glen Spean for the length of time required to form the "roads" by erosion, and to accumulate the deltas, the cols by which their surplus waters escaped during those periods must have cut a channel in the rocks in the same way that the rivers (which now represent the same drainage, or probably less) have since excavated their channels in the present valleys; whereas, although there are indications of water-wear in the passes, nothing like a defined river channel exists. Prof. Nicol attempted to explain the facts on the theory of the "roads" being sea beaches. But the absence of corresponding beaches outside those glens—the limitation of the highest "road" to Glen Gluoy—and of the second and third to Glen Roy, and the total absence of marine remains in any of the various drift beds, renders the marine hypothesis inadmissible.

Sir John Lubbock, looking at the form of the "roads" which has been described by Macculloch as parallel layers applied in succession to the sides of the hills, contends that such a form is incompatible either with the heaping up of materials on a shore line, or with their removal by erosion, as in the one case a notch and in the other a projecting ledge in the hill side would be formed, whereas, with one exception of one superior talus pointed out by Macculloch, no such structure exists. Sir John points out that a parallelism between the slopes may, however, have been formed by wavelet action, in consequence of the detrital matter taking, as it successively fell and was removed, the same angle of repose as that which the detrital slopes originally had, that angle being the same in water as in air.

Besides these objections to Mr. Jamieson's hypothesis, which the author considers valid, he points out the difficulty of conceiving that the Arkaig glacier could have ascended the hills at the entrance of Glen Gluoy to a height of not less than 1,200 feet, while at the same time a pass existed at the head of the glen only 500 feet high, which presented a ready outlet to the west coast.

It is a question also whether active glaciers such as Mr. Jamieson requires could have formed permanent dams to the large bodies of water pent up in Glen Gluoy and Glen Roy. Glacier lakes are occasionally formed in the Alps, as in the instance of the Margelen See; but they never last many seasons. The glacier is constantly on the move, and so long as it presents an unbroken front to the lake, so long is the barrier efficient, but when in the progress of the glacier a fissured mass of ice comes forward, the water at once escapes with greater or lesser rapidity, and cannot again accumulate until the defective ice has travelled past or the leak is repaired by winter frosts.

Equally difficult is it to imagine the existence of such vast glaciers as those of Glen Arkaig and Glen Treig, while the opposite glens of the Gluoy and Roy remained free from ice. The difference in the height of the hills is too slight to allow of so great a variation in the level of the snow line, and the cause suggested by Mr. Jamieson, viz., a great difference in the rainfall such as it now obtains in this district, can scarcely be maintained, for, although the annual fall at Fort William is 86 inches, and at Laggan 46 inches, the rainfall at Roy Bridge has now been found to be as much as 62 inches. Further, for the argument to be of any value, it should be shown that in the country further eastward, where the rainfall is much less, there was the like absence of glaciers during the second period, whereas Chambers and other geologists, including Mr. Jamieson himself, have shown that during that period local glaciers descended from every mountain range approaching or exceeding 3,000 feet in height—a height attained by the hills to the north as well as by those to the south of the Spean.

With respect to the so-called "deltas" of the Turret in Glen Roy, and of the Gulban in Glen Spean, which are supposed to have accumulated during the long time that the lakes filled the valleys, the author shows that the structure of the former is not in accordance with the bedded structure of deltas, but on the contrary, that it is formed of unstratified moraine *débris* 50 to 80 feet thick, with a thin coating of gravel water-worn and reconstructed from the underlying mass, and that the angle of terminal slope is not that of original deposition, but is due to wearing back of the terrace by the Roy, and the fall of the *débris* by weathering.

These are the objections of the author to the hypothesis of Mr. Jamieson, but while objecting to this exposition of the glacial theory, he considers that that theory affords the most satisfactory solution of the problem, only that he would suggest a different interpretation in explanation of the phenomena.

Dismissing the hypothesis of local glaciers of the second period of glaciation, the author falls back upon the original idea of Agassiz with the development acquired by more recent research, and assigns the Lochaber lakes to the close of the first period of great glaciation. He considers the phenomena are due to the peculiar physiographical conditions of the district, and shows that owing to the configuration of the country, the drainage of the Ben Nevis range is diverted into the lower part of the Spean Valley and the Great Glen near Fort William. These conditions which now give this area an excess of water drainage, must in the like manner, during the glacial period, have there led to an exceptional accumulation of ice.

The observations of MacLaren, Chambers, Milne-Home, Jamieson, James Geikie, and others, sufficiently prove the great thickness of the ice covering in this part of Scotland during the first period of intense glaciation. On the flanks of the Ben Nevis range, glacial striæ extend to a height of more than 2,000 feet, while everywhere the rocks in the lower parts of Glen Spean are intensely glaciated, as are also those at the head of Glen Roy on approaching the Col to Glen Spey, and around the Cols of Glen Glaster and Makoul. At the same time, the erratic blocks, with the beds of sand and gravel of foreign origin, which have been found widely distributed over the hills around Glen Roy to heights of from 800 to 2,100 feet, afford confirmatory testimony of the depth of the land ice which then covered the country.

With the incoming of this glacial period, local glaciers must have descended from every mountain range, and so long as the glacier of one steep glen became confluent with another of the same chain flowing in the same general direction, so long would their course be uninterrupted, and the propelling and abrading force maintained, as in the Alps at the present day; but when, emerging from these glens into valleys of small gradients dividing the several mountain chains, they met with glaciers descending from these other ranges, their progress was not only subject to be checked, and their forces neutralised, but their course diverted, for if the lines of natural drainage were barred, the ice took those of least resistance, although such might be uphill and against the lines of drainage. This, however, could not be effected without excessive pressure and heaping up of the ice at the points of junction.

These interferences must have been especially frequent in the valley of the Spean. On the one side, the glaciers descending the steep ravines of the Ben Nevis range, would issue into Glen Spean and project across it to the Glenroy hills opposite. Below to the west, the great Nevis Glen glacier emerged into the valley of the Lochy, while above to the east the great glacier, issuing from Glen Treig, flowed down Glen Spean; but, meeting with the aforesaid group of glaciers from Ben Nevis, was partly diverted over the flanks of Craig Dhu, and upon the entrance to Glen Roy.

While the glaciers from this system of mountains were becoming confluent in and filling Glen Spean, those from the opposite range of hills were descending Glen Roy, the Rough Burn, and the other ravines of that chain, and coming into collision with those of the Ben Nevis range. In the same way other valleys were focussing their glaciers upon the end of the Great Glen north of Ben Nevis, barring in that direction the passage of the ice down Glen Spean, and diverting it northward towards Loch Lochy and Loch Oich.

Therefore, the great mass of ice descending Glen Spean, in consequence of meeting with these obstructions, was driven to accumulate in mass in the lower part of that valley opposite Glen Roy, until overcoming further resistance and confluent with the Ben Nevis mass, it wheeled round into the Great Glen at Loch Lochy.

There is no doubt, also, from the direction of the striæ and

the position of the transported boulders, that the mass of the Treig glacier struck across the valley of the Spean, and turned down its channel westward; but that a part ascended to the Col of Glen Glaster, and another passed up the Spean Valley, is doubtful. It is more probable that this glacier, after traversing Strath Spean, met with others coming down the Rough Burn, while these took an easternly direction to Loch Laggan and over the Pass of Makoul. The direction of the striæ observed by the author between the Rough Burn and Moy, points, he considers, to ice coming down from the hills on the north and joining this main east stream.

The effects of these great conflicting ice streams were not confined only to the piling up and accumulation of the ice. Although glaciers confined by the walls of narrow glens, and descending steep slopes exercise great abrading power, the observations of Charpentier and others show that when they emerge into broader and flatter valleys, they may pass over beds of loose detritus without disturbance except that of pressure. The terminal moraines of the many glaciers emerging into Glen Spean may, according to the varying conditions of the ice, have been pushed forward or rolled over by the ice, while the meeting of conflicting glaciers must have led to the deposition and heaping up of the glacial *débris* at the points of junction. The many checks and blocks that must have occurred during the growth of the great ice-sheet—the neutralisation of the ice-force in one place, and the centralisation of it in others—will serve to explain much that is peculiar in the distribution of this sub-glacial *débris* or Till, not only in Lochaber, but in other parts of the country, and at all levels.

The author then points out the many mounds and terraces in the Spean Valley formed of moraine detritus, though since levelled and often masked by a covering of gravel due to subsequent water action. To this cause also he attributes the large accumulation of *débris* at the entrance to Glen Roy, between Bohuntine and Glen Glaster, where he shows it to be in places 200 to 300 feet deep, and where it rises nearly to the level of the lower parallel road. Mr. Milne-Home has pointed out a similar deposit at the entrance to Glen Collarig, while the large mass at the entrance of Glen Spean, and now forming Unachan Hill, rising to a height of 613 feet, has been often described.

The next question discussed is the height of the land in relation to the sea at the period of the great glaciation, as it is not possible to suppose that with the great changes of level which took place subsequently, there is now a return to the *status quo ante* of the earlier period; and the author sees reason to conclude that the land then stood at not less than from 1,000 to 1,500 feet higher than at present, so that the Irish Channel was then above the sea level, and land extended a considerable distance westward from the present coast of Scotland.

This was followed by a submergence of not less than 1,200 to 1,500 feet in central and northern England, Wales, and Ireland, and of 600 feet in the southern part of Scotland, as proved by the occurrence of marine shells at those heights, and assuming for the north of Scotland a submergence, at all events, of 400 or 500 feet below the present level, this, added to the previous elevation of 1,000 to 1,500 feet, would establish a difference of 1,500 to 2,000 feet between the period of great glaciation and the succeeding period of submergence.

This difference of level would produce a twofold effect upon the climate—the one resulting from altitude which would be equal to a rise in the mean temperature of from 4° to 6° F., and that caused by the conversion of a continental area into an archipelago. The effects of the two causes could not be less than from 12° to 15° F., which is about equivalent to the difference of climate between Paris and St. Petersburg. There is also to be taken into account the probable increase of heat consequent on the gradual diminution of those conditions, whatever they were, to which was owing the cold of the glacial period.

The effect of those changes was to produce a thaw which gradually led to the destruction of the great ice-sheet, though subsequently other changes brought for a time a return of cold sufficient to maintain local glaciers in the higher mountain ranges. The conditions under which the ice-sheet would be placed during this period would be similar to that of glaciers where they extend below the snow line. In Europe the glacier gradients are usually so steep, and the ice is so fissured, that even in such positions water rarely lodges on the surface, but in the Himalayas, where glaciers descend into wide valleys with small gradients, and the summer heat is considerable, the glaciers often become covered with tarns and small lakes. They have been noticed by Sir J. D. Hooker, and more lately by Col. Godwin-Austen, who describes in the middle of one of these glaciers, a series of such lakes, some being 500 yards in length, and 200 to 300 in breadth, and of great depth. As intervening barriers give way, these lakes descend from lower to lower levels, and finally escape.

In the same way the old ice-sheet must have become covered with pools and lakes, for owing to the irregular surface of the ice, and the inevitable absence of all channels of drainage, the water must everywhere have lodged, until channels were formed, and a means of escape established. The extent of these bodies of water would depend upon the height and permanence of the obstructions. In the Lochaber district they were, owing to the causes before named, of great size and permanence, such as to form high barriers at the entrance to Glen Roy, Glen Spean, and Glen Gluoy, behind which the waters accumulated and rose until they found a channel of escape over the cols at lower levels, when a permanent water-level would be established so long as the main barriers existed.

It is well known that the Parallel Roads are terraces composed of perfectly angular fragments of the local rocks with a few rounded pebbles both local and foreign to the district. The former show an entire absence of any prolonged beach wear. The wear of the latter is due to other causes. The slope of the hills above and below the "roads" varies from 25° to 40°, and the inclination with the horizon of the "roads" themselves, which are from 50 to 70 feet wide, varies within the limits of from 5° to 30°.

Of the internal structure of the "roads" very little is known. The only published section is the one given by the Rev. Thomas Brown in his paper on the "Parallel Roads," and in this there is no appearance of any such structure as would result from successive additions to the ledge by the tipping over of *débris* removed from the shore.

Although, therefore, the "roads" indicate a line of water-level, there is nothing in their form or structure to show that they have been formed by the long-continued action of lake waters on a shore line. To what, then, are they to be ascribed?

What the conditions were immediately antecedent to the formation of the first, second, and fourth road, is not shown, but in the case of the third road the conditions preceding its formation are to be traced uninterruptedly from the conclusion of No. 2 "Road." When the lake stood at the level of "Road" No. 2, its waters escaped by the col leading to Glen Spey, while, when they stood at the level of No. 3 "Road," they escaped by the Glen Glaster Col. Now, as there is a difference of 76 feet between the height of the two cols, it is evident that a barrier must have existed on the latter col during the time the lake stood at the higher level. Whether the barrier was detrital or ice-formed is immaterial for the argument.

Now, it is well known to engineers that a breach once established in a detrital barrier becomes so rapidly enlarged that, if not at once stopped, nothing can stay the rapid destruction of the barrier, as, in the case of the Holmfirth, Crinan, and other floods. Nor is evidence wanting of similar catastrophes in connection with glacier lakes. In the notable case of the Gietroz Glacier barring the valley of the Drance, a lake nearly 2 miles, and at one end 200 feet deep, was drained in twenty minutes. The still greater flood recorded by Vigne in a branch of the Indus drained a lake formed by a detrital barrier, and estimated by Mr. Drew to have been 35 miles long by 1 mile broad and 300 feet deep at its lower end, in one day.

In the same way it is to be assumed that the Glen Glaster barrier, which was probably formed by a remnant of the glaciers descending from the mountain ranges (2,994 feet) at the head of the glen, gave way with great suddenness, and caused the rapid fall of the waters from the level of the higher "road" in Glen Roy to that of that glen's second "road," at the height of the Glen Glaster Col, when the escape of the waters was stopped.

Now, it must be borne in mind that at this time the great mantle of snow and ice which had so long covered the country was passing away, leaving the surface of the hills in Glen Roy covered with a thick coating of angular local *débris* mixed with sand and clay, the result of the intense cold and of the decomposition of the underlying schistose and granitic rocks. This and the glacial *débris* must have long remained bare and unprotected by vegetation; at all events that below the water-line was so. Now, the angle of repose of purely angular and subangular *débris* varies within the limits of from 35° to 48°, but that of clayey sands, which, when dry, is from 21° to 37°, becomes,

when saturated with water, as low as 14° to 22°. The angle of repose of the hill-side *débris* would, therefore, depend on the relative proportion of the angular materials and their matrix, and on the extent of saturation. The slopes of the hills being on the whole greater than that of the angle of repose of the saturated under-water rubble, this latter, easily set in motion on the settlement of its constituent parts as the water drained from it would, as the level of the lake water fell, tend to slip or slide down with the falling water, and this slip would continue until the disturbing cause ceased, and the momentum of the mass was checked by the inertia of the water gradually coming to rest on reaching the level of the col of escape.[1] The effect of the arrested slide would be to project the mass more horizontally forward, and form a ledge. This ledge, modified slightly by subsequent subaërial action and weathering, and by the dressing of its slope on the occasion of the next fall of the lake, constitutes the "road."

Although in the case of the other "roads" there is not the same evidence of a minor col-barrier, as the results are alike in all, the causes which led to them must have been the same; and it is shown that there is nothing incompatible in the features of the ground with the existence of such barriers, or rather that there is some evidence in each glen, however slight, of water-lines at levels higher than the "roads."

Comparing the theoretical inferences of structure with the facts, so far as they are known, Mr. Brown's substratum of "clay with boulders indistinctly stratified with thin (lenticular) layers of sand," represents the sliding detrital mass; the finely stratified sand and clay—the sediment which subsided from the muddy lake waters after their fall; and the two to three feet of stones with clay—the subaërial fall of *débris* from the slopes above. In the substratum and overlying sediment, Mr. Brown found four species of fresh-water diatoms, while he found none in the upper bed. This fact serves to confirm the subaqueous origin of the body of the ledge, while it tends further to disprove the marine hypothesis.

Although there is in all the cols an entire absence of a defined water channel, such as would be worn by the long-continued flow of a river, there are in all of them traces of strong water action, such as might result from the temporary passage of a large and rapid body of water.

With respect to the main barriers acting as dams to Glen Gluoy, Glen Roy, and Glen Spean, they were due, as already pointed out, to the circumstance of an accumulation of ice at these spots so excessive and so high as to last long after the ice generally in the lower tracks had given way. Not, however, that any ice barrier could have been permanent for a great period of time, but this the author's hypothesis does not require. In any case, an ice-barrier in a state of rest will form a more effective barrier than when in motion.

Passing over the barrier at the entrance to Glen Gluoy, it is shown that the point where the Glen Roy barrier existed is that where a glacier coming down Glen Roy would meet in opposition the ice from Ben Nevis and the Spean Valley; and that this glen was occupied by a glacier is proved by the occurrence of glacial striæ on the rocks forming the bed of the valley near Dalriach, and of Till, or boulder clay, lower down the valley, nearer Achavady. But the great mass of the latter lies precisely on the spot where the Ordnance Survey have placed the line of barrier; it was there heaped up by the same conflicting causes that produced the barrier of ice. That it was originally larger and higher is proved by its occurring on the two sides of the valley, the river having worn a channel through it, and by the presence upon it of thick beds of water-worn and water-strewn gravel, the materials of which have been derived from the underlying deposit, and which was formed, in all probability, by the rush of the waters on the bursting of the barrier, for, in many places the gravel is thrown back and over, as though by downward and outward pressure of water in motion. This detrital mass extends for a length of two miles or more.

The great barrier needed at the entrance of Glen Spean is precisely on the gronnd that the great glaciers of Ben Nevis met the ice stream coming down Strathspean. Unachan Hill, which rises immediately behind the line of barrier marked by the Ordnance Survey, together with the rising ground on the flanks of the valley, consist of a thick substratum of till or boulder clay, with a covering of gravel, the latter formed in greater part, if not entirely, from the destruction of the former, so that there is little doubt that the detrital barrier here also was at one time much more important. Still, although the detrital matter formed a considerable element, the author believes that the great mass of ice constituted the essential element in the barriers.

The Till, although accumulated in larger masses in the above-named sites, is found in places all up the valley, generally in the form of terraces covered by gravel, as at Inverroy, Murlaggan, Inverlaire, and elsewhere. There is one feature common throughout, namely, the levelling and terracing of this glacial *débris* by subsequent water-action, which could not have been effected in the still waters of a lake bed, but probably took place on the bursting of the main barriers and during the rapid outflow of the waters. The levelling of the original glacial mounds having been effected at the time of the drainage of the lakes, and having been then covered and masked by gravel, the terminal slopes were either formed at the same time by the outpouring waters as they fell to a lower level, or subsequently by wearing back by the present streams.

An objection may occur to the foregoing hypothesis, in that, with elements so variable as the problem has to deal with, the parallelism of the "roads" with the horizon, which has been remarked on by all observers from Macculloch downwards, could not have been maintained. For the detritus of the hill sides vary, however slightly, in the relative proportions of rock fragments and soil, while the slopes above and below the "roads" vary also in their angle, so that, as these conditions varied, so would the momentum of the sliding mass vary, whilst the resisting force of inertia would remain the same. The consequence would necessarily be, that the slide would continue at some places to a lower level than at others, and the line of the "roads" could not be throughout parallel with the horizon.

There is no doubt that, to all appearances, the "roads" are perfectly level, and such was the author's first impression; but afterwards, on referring to the elaborate 6-inch Ordnance maps, he found the levels there given clearly show that the "roads" are neither at the exact height of the cols nor are they perfectly parallel with the horizon, after allowing for the variable inclination of the "roads," and for the observations being made in their centre.

Instead of a perfect level water line, the "roads" are really slightly *waved*, the difference between the highest and lowest point being in the four "roads" taken in descending order, 15, 11, 15, and 12 feet; and while the level of the higher "roads" is in most instances *below* those of the several cols of escape, that of the lower "road" is in all instances *above* it. Thus in Glen Gluoy, the "road," which is never more than 1 foot above the level of the Turret Col, is in places 14 feet below it. The Glen Roy "roads," Nos. 2 and 3, rise 2 and 4 feet above the col of the Spey, and sink 7 and 13 feet below it; whereas No. 4 "road" is never less either in Glen Roy or Glen Spean than 2 feet, and rises at places to 10 and 14 feet, above the Pass of Makoul. Further, as the curves formed differ for each "road," the variations *cannot be due to a common cause, such as subsequent movements of the ground*, but must be owing to differing conditions in each case. Nor do the levels on the two sides of the valleys correspond; they often vary as much as 7 or 8 feet. It is therefore not possible to reconcile these variations with the hypothesis of the "roads" being lines of water level due to shore action; nor is the very variable inclination of the "roads" themselves compatible with that view.

In the higher "roads" the lower level of the curve is possibly due to the steeper slopes, whilst the fact that the lower "road," No. 4, remains above the level of the Pass of Makoul, may be due to the circumstance either of the slopes being less, or more probably to the fact of the lake having been so very much larger, the escape of the waters was more prolonged, and the fall slower.

Various phenomena in connection with the great ice-sheet in Lochaber, and their connection with the gener l question, are next considered. The author objects to the term of *moraine profonde* to describe the drift of sub-glacial origin, as apt to lead to misunderstanding, although Hogard and other geologists have used it in a wider sense. It is evident that the old ice-sheet acted under very different conditions to an ordinary glacier, and it is better to use such terms as moraine detritus or sub glacial detritus for the sum total of sub-glacial products of the former, than employ a term which was originally and still is generally restricted to a single and comparatively small product of the modern glacier.

Besides this sub-glacial *débris*, there is the larger quantity of

[1] Even now considerable slides occasionally take place on the steeper slopes of Glen Roy.

débris that must have been scattered over the surface of the ice during its melting by streams and rivulets, or spread out in the temporary lakes which were formed at all levels, and may have given rise in many instances to sand and gravel terraces of variable extent. But though true beaches may be deposited in other glacial lakes, for ledges or shelves such as constitute the Parallel Roads to be formed, a number of conditions must have concurred—such as sufficient slopes, a detrital covering, barriers at the mouth of the glens, and cols of escape at their upper end.

As the barrier ridges on the old ice-sheet melted, or burst, the waters escaped to lower levels, carrying with them, on or beneath the ice, a large portion of the surface detritus. Formed at all levels up to 2,000 feet or more, these glacial lake waters, in descending to lower levels, met with yet larger bodies of water, and the transporting forces increased in power till the last stage was reached and open channels formed in the distant plains, leaving as marks of their passage down the valleys—here great banks of gravel—there deep beds of sand, according to the distance from the point of outburst. To these floods, combined with river inundations, and with the modifications wrought by subsequent fluviatile action, are due various forms of escars, terraces, and other less defined detrital accumulations.

Meteorological Society, May 21.—Mr. C. Greaves, F.G.S., president, in the chair. The following were elected Fellows of the Society:—A. C. Bamlett, C. Browne, H. Burkinyoung, W. Radford, F. Ramsbotham. The adjourned discussion on the Rev. W. Clement Ley's paper on the inclination of the axes of cyclones was resumed and concluded. The object of this paper is to call attention to the evidences recently afforded by the results of mountain observations to the theory that "the axis of a cyclone inclines backwards." The author first reviews the state of the question up to the present time, and details his own investigations chiefly founded upon the movement of cirrus clouds; he then refers to Prof. Loomis's recent "Contributions to Meteorology," in which is discussed the observations at the summits and bases of several high mountains, the results of which confirm the theory that the axis of a cyclone inclines backwards. The following papers were read:—On observations of the velocities of the wind, and on anemometers, by G. A. Hagemann.—On the relation between the height of the barometer and the amount of cloud, as observed at the Kew Observatory, by G. M. Whipple, F.R.A.S. The author shows that the average amount of sky clouded at Kew is a little less than seven-tenths of the whole, and that the amount covered varies inversely as the barometric pressure between the limits of 29·0 and 30·3 inches, the variation being the most rapid between 29·8 and 30·1 inches. Also that above 30·3 inches cloud increases with increasing pressure, attaining the mean about 30·5 inches, and rising above it at 30·6 inches.

PARIS

Academy of Sciences, May 19.—M. Daubrée in the chair.—The following papers were read:—Meridian observations of small planets at the Greenwich and Paris Observatories during the first quarter of 1879, communicated by M. Mouchez.—On the resistance of elliptical boilers, by M. Resal.—On a new derivative of nicotine, by MM. Cahours and Etard. This is got by heating nicotine (100 parts) and sulphur (20 parts) together. The sulphur acts first by removing hydrogen from the nicotine. When at 160° to 170° the mass has become fluid and chrome-green in colour, the heating is stopped; and in a few days yellow prismatic crystals are formed of the new substance. Sundry reactions are described. The authors consider nicotine as probably a combination of dipyridine and hydrogen. Sulphur, acting on 2 molecules of nicotine, transforms it, with separation of sulphydric acid into *tetrapyridine*.—Formal reasons of the economical superiority of the Woolf or compound engines, by M. Ledieu. These are shown in tabular form.—Researches on the proportion of carbonic acid in the air, by M. Reiset. He operated with large aspirators, of about 600 litres capacity, movable to various parts. He finds that free atmospheric air contains, on an average, 2·942 vol. carbonic acid per 10,000 vol. (The common statement is that the quantity in atmospheric air varies between four and six ten-thousandths in volume.) In very diverse conditions the extreme variations did not exceed 3 per 100,000. Comparative observations in woods and in fields showed small differences, the numbers being 2·917 CO_2 and 2·902 CO_2 respectively, for the same hour. Other cases were: Over a field of red flowering clover in June, 2·898 CO_2; over one of barley with luzerne, in July, 2·829 CO_2. Among a flock of 300 sheep in pasture, 3·178 CO_2 (showing a considerable increase); at Paris, in May, near the Parc Monceaux, 3·027 CO_2.—M. Daubrée communicated news of M. Nordenskjöld. Whalers had seen what was probably the *Vega*, blocked in ice near Behring Strait, not far from East Cape.—Mr. A. Hall was elected Correspondent in Astronomy in room of the late M. Santini.—On the transparence of the media of the eye for ultra-violet rays, by M. Soret. He operated with the eyes of oxen, calves, and sheep, using his spectroscope with fluorescent eye-piece. It is shown that the absorption by the whole of the media must render impossible the perception of rays whose refrangibility exceeds that of the extreme radiation of the solar spectrum, or the line U. The absorbent properties of the vitreous and aqueous humours are attributed to presence of albuminoid substances. The limit of transparence of the two humours is indicated by curves.—Independence of changes of diameter of the pupil and of variations of the carotidian circulation, by M. François Franck. The iris may be dilated or contracted independently of modifications of the circulation.—A letter from Buffon to Laplace in 1774 was communicated by the Marchioness de Colbert-Chabanais.—On the characteristics of functions Θ, by M. Jordan.—On functions such as $F(\sin\frac{\pi}{2}-x) = F(x)$, by M. Appell.—On a property of entire functions, by M. Picard.—On the functions introduced by Lamé in the analytical theory of heat relating to ellipsoids of revolution, by M. Escary.—Preliminary study of the action of acids on salts, without intervention of a solvent, by M. Lorin. The results indicate in general a chemical action more or less marked, and which for fatty acids decreases from formic acid to each of its successive homologues. Applications:—1. Crystallisable acetic acid may be obtained with acetate of baryta and sulphuric acid. 2. 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THURSDAY, JUNE 5, 1879

SCIENCE TEACHING IN LONDON BOARD SCHOOLS

IT was a fortunate circumstance that at each of the three elections of the School Board for London science has been represented. On the first occasion Marylebone gave Prof. Huxley a seat at the board, and at the second and third elections Chelsea has sent Dr. Gladstone as one of its representatives. To the former was due, in great measure, the Code of Regulations in which the subjects of instruction were laid down. To the latter has fallen the task of bringing them into a systematic and practical form. The Committee, of which Prof. Huxley was the chairman, determined that there must be given, in infant schools, "object lessons of a simple character, with some such exercise of the hands and eyes as is given in the Kindergarten system"; and in boys' and girls' schools, "systematised object lessons embracing in the six school years a course of elementary instruction in physical science, and serving as an introduction to the science examinations which are conducted by the Science and Art Department." The time-tables of all the schools under the Board are made to conform to these requirements; the walls of the class-rooms are hung with illustrations in natural history and other diagrams; and in many of the schools boxes of objects are also to be found. Many of the teachers, especially those trained by the Home and Colonial Society, endeavour to carry out the regulations as fully as practicable; but hitherto the scheme has worked very irregularly, and there has generally occurred a break of continuity on the children passing from the infants' departments to the upper schools. The Board's Inspectors, who are required to report in all cases on object teaching, have often had to bear testimony to this defect.

In November last the Store Sub-Committee, of which Dr. Gladstone is chairman, prepared a systematic scheme to supply the deficiencies of the former regulations, which has been adopted by the Board. The syllabus is as follows:—

Infants' School (Non-Standard Children).

Aim.—To develop in the children's minds an interest in the things round and about them; to teach the use of all the senses, and form habits of observation; to impart a correct knowledge of the commonest things; to increase the infants' vocabulary and power of expressing themselves.

Subjects of Instruction.—Objects illustrative of the three kingdoms of nature—animals, plants, and minerals, especially such as the children meet with commonly in their ordinary life. The different parts, qualities, and uses of these objects.

Means.—Diagrams; objects procured by the teacher or supplied from the store, and a small case of apparatus to enable the teacher to perform the simplest operations necessary to illustrate the properties of the objects. Children are to be encouraged to bring the needful objects both in this and subsequent stages.

Standard I.

Aim.—To carry on the previous training, leading also to the exercise of the judgment, in showing the relations of the different parts of bodies, and how their different qualities fit them for the uses to which they are applied.

Subjects of Instruction.—A somewhat more extended series of objects, with fuller information as to the qualities, uses, and history of common things.

Means.—Diagrams of animated nature, &c., classified—small cabinet of objects, classified for purpose of comparison, with simple apparatus as before.

Standards II. and III.

Aim.—To lead up from the previous training to the "specific subjects" of the Code.

Subjects of Instruction.—Series of objects illustrating the most important manufactures. Geographical distribution of products and means of procuring them. Objects for teaching the fundamental notions of matter and force.

Means.—Diagrams—same small cabinet as before. Loan collections of objects tracing the raw material to the final product (such as cotton, flax, silk, leather, wool, iron, and clay).

Standards IV. to VI.

Aim.—To teach the "specific subjects" of the Code.

Subjects of Instruction.—One at least of the following:—

Mechanics. Taught by diagrams and working models (on loan).		
Physiology.	ditto	models (on loan).
Physical Geography.	ditto	maps and experiment.
Botany.	ditto	specimens and models.
Domestic Economy.	ditto	demonstrations and experiment.

The practical instruction which, during such a course as the above, will be imparted to the children, is altogether in advance of what is contemplated by the new code of the Education Department. The Government have provided that an annual grant of 4*s.* per subject be given for every scholar in the Fourth, Fifth, and Sixth Standards passing in not more than two of these "specific subjects;" but they give no grant for any of the preliminary teaching which under this scheme is intended to lead up to these studies. This defect in the scheme has been brought before the notice of Parliament year after year by Sir John Lubbock. The London School Board has therefore decided, on the motion of the Hon. George Brodrick, that an application should be made to the Education Department to get the teaching of the elements of natural science included among the recognised subjects of class examination—history, geography, and grammar; and a deputation will shortly wait upon the Lord President of the Council with that object.

This will manifestly be a step of very prime importance not only to the School Board for London, but to all those in the Provinces, and to the cause of education in general, as the possibility of thus obtaining a grant for the teaching in the lower standards will be the most effective stimulus that can be applied. Whatever, however, may be the result of this application, the London Board will not be deterred from fully carrying out the programme they have set themselves; and they have prepared a circular of instructions to their teachers, full of excellent and valuable suggestions, which is to be

accompanied by a box of apparatus, simple and cheap, to enable the object-lessons to be properly illustrated. Loan collections of models illustrative of mechanics, physiology, and botany, will also be provided; but as far as possible the children are to be encouraged to bring familiar objects, and to make their own models and apparatus. After giving very full directions for the teaching of the infants and the first standard children, which we need not insert in detail, the course prescribed for the upper classes is as follows:—

Standards II. and III.

As the aim in these standards is to lead up to the specific subjects of the Code, the teaching must be more advanced, and should make a larger demand on the thinking powers of the children.

The objects contained in the previous groups should be again employed, but fresh ones should be occasionally introduced, especially for the purpose of comparison.

In the animal group children should be led to compare and classify the different animals, and to notice the chief differences and resemblances between the leading divisions of the animal kingdom. The children should also have explained to them the preparation, qualities, and uses of animal substances employed in the arts, such as leather, silk, wool, and horn.

In the vegetable group such distinctions as that of endogen and exogen should be made clear; the gradual growth of plants such as beans and wheat should be traced; the uses of vegetable substances, such as cotton, linen, starch, sugar, coffee, tea, and india-rubber, with the processes of manufacture, should be explained.

In the mineral group attention should be called to the general properties of metals, iron, copper, silver, gold, lead, tin, zinc, mercury, &c., and the qualities peculiar to each. The iron and steel manufactures, and the making of bricks, pottery, earthenware, &c., may be explained; and the distillation of coal and manufacture of gas, may be experimentally illustrated.

The knowledge of the points of the compass, and form and motions of the earth, which is required by the Code, will naturally be imparted by means of object lessons.

This object teaching may be connected, as occasion offers, with the lessons in geography, and may often be made to illustrate the reading and dictation lessons.

The teacher is not expected to attempt to teach all the subjects mentioned in the preceding paragraphs, nor to limit himself to them, but the Inspector will inquire what particular course the object lessons have taken, and will frame his examination accordingly, taking care that the fundamental facts connected with matter and force are not overlooked.

Standards IV. to VI.

Though in the higher standards one or more of the scientific specific subjects of the Code is expected to be taken, it will be generally found necessary to continue some of the training just described. Thus, in the Fourth Standard, lessons on the principles which are at the foundation of all physical, mechanical, and chemical science should be given; during which clear ideas should be imparted as to size, weight, and specific gravity, as to the laws of motion of solids, liquids, and gaseous bodies, as to the production, radiation, conduction, and absorption of heat, and as to the difference between chemical combination and the mere mixture of the constituents. Occasional lessons also on the atmosphere and its composition, and the ordinary meteorological changes should be given, and local phenomena of springs, streams, hills, ponds, excavations of the soil, &c., should be observed. Boys as well as girls should be taught something of the laws of health. Domestic economy should not be taught empirically, but the scientific principles involved in the lighting of a fire, in cooking, in the choice of clothing material, in washing, and in ventilation, should be experimentally explained.

The foundations of a "knowledge of common things," as Dr. Lyon Playfair happily called it, will thus be well laid; and the children of the London schools will at an early age acquire the habit of correct observation—no mean advantage whatever may be their future occupation in life. This additional course of instruction will not occupy more than about two hours a week, and will involve scarcely any extra expense, while it will sharpen the wits of the children and freshen their minds for their more literary studies.

NOAD'S "ELECTRICITY"

The Student's Text-Book of Electricity. By H. M. Noad, Ph.D., &c. A new edition, carefully revised, with an Introduction and Additional Chapters by W. H. Preece, M.I.C.E., &c. (London: Crosby Lockwood and Co., 1879.)

IN his introductory note to this new edition of the "Student's Text-Book of Electricity," Mr. Preece informs us that the revision is only partially his own, having been begun by Dr. Noad shortly before his lamented decease. In fact a large portion of the work appears to be reprinted from former stereotyped plates.

In addition to a large number of illustrative cuts, the work possesses a very valuable feature, too rare in elementary books, namely, frequent references to important original memoirs. A judicious use is made of extracts, as, for example, from the lectures of Prof. Fleeming Jenkin on submarine telegraphy, and from those of Sir W. Thomson on atmospheric electricity and terrestrial magnetism. New chapters on telephones, duplex and quadruplex telegraphy, and on the electric light, bring up the scientific information to the present year. As an elementary treatise on the purely phenomenal side of the science of electricity, it is probably the fullest text-book in the language.

Having said this, our commendations must end. Mr. Preece's opening paragraph bears the stamp of being an excuse for the shortcomings of the work; and we must regard it as his misfortune, rather than his fault, if a book which he has had to revise fall far short of what it might have been had it been produced under his sole responsibility. It is unfortunately—in science, at least—the reviewer's duty to be candid on the shortcomings of the work under his notice; and the only way to prevent the repetition of erroneous statements, and to secure their effective correction, is to point them out fearlessly. We are bound, therefore, to undertake the ungracious task of indicating sundry blemishes which it is to be hoped will not be perpetuated in another edition.

There appear to be several discrepancies between the earlier and the later parts of the book. On p. 178 mention is made of "a battery known as the *Pile Marie Davy*," in which *sulphate of mercury* is used; and which is stated to be *weaker* than Daniell's cell, but to have *been used to some extent in France.* On p. 434 appears an account of the "*Marié-Davy Battery*," which "has been *much used in England, and is largely employed in France and on the Continent.*" It is twice stated to contain *bisulphide of mercury;* and lower down on the same page it is declared on the authority of Latimer Clark to have an electromotive force of 76, as compared with 56 for a Daniell's cell.

The divided ring electrometer of Sir W. Thomson is described on p. 79. Another description and a figure of the instrument are given on p. 529. The quadrant electrometer, of which there is no mention in the early chapter where Peltier's and other electrometers are given, is described at some length and figured on p. 537.

In a couple of pages devoted to the "Insufficiency of the Contact Theory" of voltaic electricity, the authorities cited are Faraday, Roget, and "lastly," Sir W. Snow Harris; the later fundamentally important researches of Hankel, Thomson, Kohlrausch, and Clifton, being absolutely ignored.

Two pages (22 and 23) are devoted to Varley's multiplier, but there is not a word about the earlier invention of Nicholson, nor the more recent "replenisher" of Sir W. Thomson. Nor is there a single word about the Holtz machine.

In magnetism there is no attempt to explain the meaning of the term "declination," and the word "variation" is made to do duty both for declination and for the variation of declination, in a manner most perplexing to the uninitiated in electrical terms. And yet the book is avowedly "written under the idea" that the student "approaches the subject from the datum line of ignorance!"

We cannot accept without protest the following statement:—

"The fall of tension is always accompanied by its conversion into heat" (p. 198). Nor this: "With sulphuric acid the iöns (*sic*) are H and SO_4 (Sulphionide of Hydrogen)."

The term the "*absolute quantity of electric force in matter*," used on p. 223, is open to serious objection. On p. 209 we read that "the common non-absolute unit of work involving the product of a weight into a length is styled *kilogramme*, or foot-pound."

The following statement:—"we have, calling C the charge, Q the quantity, and S the surface, $C = \frac{Q^2}{S^2}$," appears on p. 61. After pondering over this formula, we give it up.

We are compelled to take exception to the following manner of stating the well-known law of Ohm:—"Thus let F denote the actual force of the current, that is, its power to produce *heat*, magnetism, chemical action, *or any of its other effects;* E the electromotive force, and R the resistance of the wires and liquids, then $F = \frac{E}{R}$" (p. 199). To say nothing of the assumption that all the "effects" of the current are simply proportional to the current strength, we protest against the introduction of that much-abused word, *force*, where every other treatise on electricity in the language has put "strength" of current or "quantity" of current or "intensity" of current. On p. 209 the formula again appears, this time as $C = \frac{E}{R}$, which is the form adopted by Maxwell, Jenkin, Culley, Foster, Chrystal, the British Association Committee, and in the well-known treatises of Ganot and Deschanel. Guthrie uses $Q = \frac{E}{R}$, and the form $I = \frac{E}{R}$ is used by Maxwell, Cumming, Clark and Sabine, Verdet, Daguin, Wiedemann, Jamin, and continental writers generally. It is very desirable that needless departures from one or other of the established forms should be discouraged. The "Return Charge" of the Leyden jar, so-called on p. 46, is now almost universally denominated the "residual" charge, a term which is far preferable, as it cannot be confounded with the return shock or return stroke, or "back stroke," as it is termed on p. 91.

In the chapter on the telephone occurs the following passage:—"In 1874 Mr. Elisha Gray, of Chicago, America, succeeded in effecting the transmission, through a wire, by means of electricity, of the variable intensity, as well as the pitch of a sound. Subsequently he invented a form of telephone by which all the three characteristics of sound could be transmitted. *As a result, the electrical transmission of articulate speech became an accomplished fact.* It remained, however, for Prof. Graham Bell, of the Boston University, to accomplish this latter feat in the most effective manner." Do we understand Mr. Preece to endorse Elisha Gray's claims to precede Bell as the inventor of an *articulating* telephone? As a minor blemish, we notice the name of Philip Reis appears as Reiss. Many persons confound the inventor of the original singing telephone with Peter Riess the author of the *Reibungselectricität;* and the misspelling of his name helps to perpetuate the error. One other quotation from the editorial add tions is not devoid of interest:—

"The subdivision of the (electric) light has recently occupied the attention of inventors. Jablochkoff works four lamps simultaneously. Wallace has worked ten. Attempts have been made to do this on a much larger scale by raising platinum and iridium to incandescence, or to that temperature just below melting-point. A soft and gentle light is thus obtained. But the result has not been commercially successful, *though probably this is the direction in which ultimate success will be obtained*" (p. 576).

We wish heartily that the editor of this new edition had himself re-written the work; a reviewer's task would then have been much more agreeable.

SILVANUS P. THOMPSON

LENZ'S SKETCHES FROM WEST AFRICA

Skizzen aus Westafrika. Selbsterlebnisse von Dr. Oscar Lenz. (Berlin: Hofmann and Co., 1878.)

DR. LENZ'S "Sketches from Western Africa" are unusually interesting and instructive. They are not descriptions of travel in the ordinary sense of the word, but form a collection of essays, perfectly independent of each other, describing in a masterly manner the natural and social conditions of that scantily investigated coast, as they presented themselves to the eminent

traveller during a journey undertaken at the request of the German African Society, and extending over three years (1874 to 1877). Everything, therefore, which Dr. Lenz describes, he has seen and witnessed himself, and apart from this important advantage the sketches have that additional one, that they are written from a completely unprejudiced and neutral point of view as far as the social or political conditions of the various West African tribes are dwelt upon. Thus a series of no less than fourteen different pictures of travel are presented to the reader, and it is indeed difficult to determine which of them are the most interesting.

After a condensed account of the previous exploring expeditions, and an explanation of the great difficulties attending all travels in Western Africa, Dr. Lenz begins his first sketch with the French colony of Gaboon. In June, 1874, he landed for the first time on African soil, viz., on the small island of Elobi in the Bay of Corisco. This bay is situated in lat. 1° N., between Capes Ninje (St. Jean) and Esteiras and contains the three islands—Corisco, the larger and the smaller Elobi; Spain numbers these islands amongst its colonies, as is also the case with the large and well-wooded island Fernando Po, a few degrees further north, with its high volcano called Clarence Pic. Between Capes Santa Clara and Pongara the sea forms a wide inlet into the coast of the mainland, and here the French have established a colony in the fine estuary of Gaboon and have extended their influence even to the mouth of the mighty Ogowe River. Two large rivers, the Muni and the Mundah, the sources of which are situated in the outskirts of the West African Slate Mountains, or the Sierra do Crystal, have their estuaries in the Bay of Corisco, which has flat banks thickly clad with evergreen mangrove trees. These mangrove swamps form the dark and dense wall which here protects the African continent against European trespassers, as they give rise to the fatal fever miasma which has won for this coast the unenviable reputation of being the most deadly one in the world. Many a traveller who landed here full of hope and with a view of exploring the interior and adding his share towards making it accessible to commerce and civilisation, has acquired in these mangrove swamps the germs of premature death; many an active and striving colonist who sent home to Europe the costly natural products of the land and who introduced to the natives the useful appliances and productions of the "n'tangani," *i.e.*, white men, here fell a victim to the ever-prevalent fevers.

From Elobi Dr. Lenz proceeded to Gaboon, a journey which in the opposite direction a steamer can perform in about eight hours, but which on account of both wind and tide coming in a south-northerly direction took some three days in a sailing vessel. The sanitary conditions of Gaboon are much better than those of the coast a little further north, yet malaria fevers are frequent. The annual mean temperature, although the colony is situated almost on the equator, does not rise beyond 27–28° C.; yet the fact that the thermometer never sinks below 20° C. makes the climate unbearable to all Europeans in the long run. The best months for travelling here are June, July, August, and the beginning of September. In the middle of the latter month the rainy season sets in and lasts till the middle of January, when a short dry season begins, lasting to the beginning of March. Then another rainy period commences and continues to the end of May. It is very peculiar that during the long dry period from the end of May till September the sky is invariably overcast, while during the rain season the sun sends down its perpendicular rays with all their intensity, the sky covering itself with heavy rain clouds only towards evening.

Dr. Lenz mentions a curious fact in connection with the sanitary conditions on the west coast of Africa:—

"It appears that amongst the European colonists each one thinks his particular place of residence to be the healthiest of all. Thus the colonists at Banana, a sandy strip of land near the mouth of the Congo, consider this place extremely healthy and know of no worse parts for fever than the Gaboon districts; but in the latter the colonists make the sign of the cross if the Congo is mentioned. The inhabitants of St. Paul de Loanda are in raptures about their upper town (in the lower town, close to the sea, there are only stores and shops) and others again designate this largest town of West Africa, the only place indeed which has a right to the name of town, as the worst plague-hole in the world. Unfortunately there is no place on the west coast which is unanimously designated as healthy (perhaps with the only exception of Mossamedes, in the south of Benguela), but on the other hand there are a number of districts about the deadly climate of which nobody is in doubt. To these Gaboon distinctly does not belong, while Cape Lopez in the delta of the Ogowe estuary does; and so does the island of Fernando Po and a number of the so-called 'oil rivers,' such as Camerun, Old and New Calabar, Bonny, Opobo, &c., places of great importance in the palm-oil trade."

The native population of Gaboon belongs to the great family of Bantu negroes, and they call themselves Mpungwe. They are a relatively fine race, and certainly superior in frame and growth to the neighbouring Akelle, Okota, and others. They have not progressed very much in civilisation in spite of their long connection with the French, yet there exists a tolerably friendly feeling betwixt them and the colonists; they are even to a certain extent guided by French laws. Their political significance is very small; the last of their kings, Denis by name, died two years ago aged over ninety years. The Mpungwe live in little huts, of which some ten or twenty form a village, and these are disseminated in every direction among the "factories" of the Europeans. The former occupation of the native Gaboonese was solely and exclusively slave trading, but at present their principal object in life seems to be to obtain goods on credit from European colonists, and to exchange them against gums, ivory, or ebony in the interior. Apart from this the slave trade still flourishes among the Mpungwe themselves, indeed the wealth of a Mpungwe nigger consists principally in the number of his slaves, whom, however, he treats very kindly. Polygamy of course exists generally among the West African natives, also with the Mpungwe, although most of the latter call themselves Christians. But with all this the superstitious customs and fetish creed of past centuries exist to this very day, and if the wealthy Gaboonese laughs at them in public he yet continues the same old religious humbug on his travels into the interior. Apart from the Gaboonese proper, the Mpungwe, different other tribes live close to the European colonies, such as the mighty Fan and

Akelle. These strive to replace the Mpungwe. To the north, towards the Mundah River, the Osekiani, the Mbenga and Mbuschu tribes are met with, which occupy the whole area of the Bay of Corisco. All these tribes speak different languages and differ in their manners and customs.

The colony of Gaboon consists of three little villages inhabited by Europeans—Plateau, Glass, and Baraka (or Libreville). They are situated about a mile from one another. The French Government house, offices, and barracks, as well as the Catholic Mission house and four or five factories are at Plateau; eight or ten English and German factories are at Glass, and the Anglican Mission house is at Baraka. Each factory forms a complex of houses by itself, all comprised in an inclosure; there is generally the dwelling-house of the colonist, the sale rooms or shops, a store-house, a kitchen (always built separately), a house for the workmen, and a shed for canoes and boats. The houses are built of wooden planks imported from Europe, and all have a verandah. The roofs are covered with mats, which are impenetrable even to the most violent rain. The only house built of stone is the Government house.

Dr. Lenz now gives minute details on the political condition of the colony as well as of the work and progress of the religious missions, and concludes his sketch by an elaborate account of the commerce of the place.

In the above we have given but a scanty outline of Dr. Lenz's sketch of Gaboon. Our readers may judge of the interest of the whole work when we state that there are thirteen other chapters equally elaborate and crowded with details. Our space will not permit us to enter further upon the subject, and we must confine ourselves to the mere statement of the contents of the other chapters. Thus we have one on the Cape Lopez colony, then the Ininga, the Fan and the Abongo tribes are treated in turn, the Fan being remarkable through their being cannibals and the Abongo through their extraordinarily small size, which entitles them to the appellation of a "tribe of dwarfs." A general description of the commercial conditions of West Africa follows, and we then come to some animated pictures of elephant and other hunting. The next chapters treat of the superstitious beliefs of the various tribes, of the free state of Liberia and the Croo Coast. A journey from the Okande land to the Osaka tribe and thence to the Aduma and the Banshaka is described in the three following sketches, and the two last ones are dedicated to a description of the Ogowe Lakes and the town of St. Paul de Loanda. We can recommend Dr. Lenz's book most heartily to all lovers of geographical and ethnographical science who are familiar with the German language.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Average Flush of Excitement

I WITNESSED a curious instance of this on a large scale, which others may look out for on similar occasions. It was at Epsom, on the Derby Day last week. I had taken my position not far from the starting-point, on the further side of the course, and facing the stands, which were about half a mile off, and showed a broad area of white faces. In the idle moments preceding the start I happened to scrutinise the general effect of this sheet of faces, both with the naked eye and through the opera-glass, thinking what a capital idea it afforded of the average tint of the complexion of the British upper classes. Then the start took place; the magnificent group of horses thundered past in their fresh vigour and were soon out of sight, and there was nothing particular for me to see or do until they reappeared in the distance in front of the stands. So I again looked at the distant sheet of faces, and to my surprise found it was changed in appearance, being uniformly suffused with a strong pink tint, just as though a sun-set glow had fallen upon it. The faces being closely packed together and distant, each of them formed a mere point in the general effect. Consequently that effect was an averaged one, and owing to the consistency of all average results, it was distributed with remarkable uniformity. It faded away steadily but slowly after the race was finished. F. G.

Lunar Crater

ON April 1 last I saw, between Landsberg and Rheinhold, a small but very remarkable crater, which does not appear in Schmidt's map. It is situated east of a line joining the centres of the above craters, and at rather more than a third of the distance from the former to the latter. Either closely adjoining, or in the position of the small crater, there is an isolated hill within the angle of a forked ridge as shown by Schmidt, who must, undoubtedly, have noticed the crater if it existed at the time of his observation. Might it be that the hill seen by him subsequently opened out as a crater? I remarked neither the hill nor the ridge, but these, like many of Schmidt's objects, might be above my telescopic power, so I cannot say whether the crater is identical with the hill or not. Nearer Rheinhold there is a smaller crater not in Schmidt, who, however, shows a similar one that I failed to see not far off to the south. This may be only a case of misplacement in the map.

JOHN BIRMINGHAM

A Remarkable Meteor

A REMARKABLE meteor was seen in Western Australia on February 1 this year. The following account has been forwarded to me by Mr. S. Worsley Clifton, Collector of Customs at Freemantle:—

"A small black cloud on a clear day appeared in the east, travelling not very swiftly towards the north-west, which burst into a ball of fire with an apparent disk the size of the full moon, blood-red in colour; it left a train of black or dark-coloured vapour across the heavens which was visible for three-quarters of an hour. No sound was heard, sky perfectly clear, and thermometer 100° F. in the shade." ROBT. J. ELLERY

Observatory, Melbourne, April 16

Disease in Salmon

THERE has lately been much correspondence upon the subject of a disease affecting the scales of the salmon, and I chanced to come upon the passage which I inclose to you in an old book, the fly-leaf of which bears the autograph of *a* Duke of Richmond, the one, I imagine, who was at Brussels in 1815. I am not a scientific naturalist, and it is quite possible that this passage is familiar to those who are conversant with such subjects; but thinking it better to err on the side of superfluity than that of carelessness, I trouble you with it. W. WALKER

May 26

Extract from Rev. C. Cordiner's Letters to Thos. Pennant, Esq., on Antiquities and Scenery of the North of Scotland. Lond. 4to, 1780.

I here beg leave to introduce a memoir, relative to an insect attendant on the salmon which come up this river (the Devron), communicated to me by an ingenious friend.

The foul salmon, of which a drawing has been already sent to Mr. Pennant, was caught February 10, 1776. When brought into the house the colours upon this fish were remarkably lively. The general appearance was that of a reddish brown; but the

spots of red and black upon particular parts, were exceedingly bright and beautiful. When one compared the whole appearance to that of a clean fish, it was wretched and disagreeable; it was lank; the belly empty, flabby, and of a dirty yellow; the jaws at a considerable distance in the middle, the under jaw with a large protuberance standing perpendicular upon the extremity; the upper jaw with a hole almost quite through (and I am told in some quite through), in which, when the jaws were shut, the protuberance lodged. Not one fin entire; the scales and skin being in many places destroyed, presented the appearance of foul ulcers. The gills were full of the *Lernæa salmoneæ;* such salmon are called *Kipper*, or foul fish.

The cruves in the river Devron are (following the windings of the river), about a mile and a half from the sea. In the sandy places below the cruves, where there is a sufficient depth of water, a great many salmon spawn. In those places they are seen raising considerable hills of sand, probably to cover and protect the spawn.[1] They are likewise seen frequently pushing and striking one another; and the fishermen assert that they have many battles: their conjecture is that the battles are occasioned by the males endeavouring to get at the spawn in order to devour it, and the females endeavouring to defend it. About these hills they remain during the winter, and until the young fry appear, unless forced off by a torrent, probably in order to keep the hills in repair and to defend the spawn from the many enemies ready to attack it. *Quære*,—Are not the form of the jaws, the foul ulcers in the skin, and the destruction of the fins owing to the above-mentioned operations? *Quære*,—If salmon spawned in the sea, would they not be found more or less in the condition of kipper? But in this condition they are never found out of the rivers.

Linnæus says of the LERNÆA *Salmonea: "Habitat in branchiis salmonum; ergo etiam marina:"* this latter is certainly a mistake; for these *Lernæa* are never found with us out of the rivers; and several sensible fishermen have assured me, that salt water proves absolute destruction to these animals.

Salmon, at a certain time during their stay in the sea, are infested by another animal of that genus, called by *Linnæus* MONOCULUS, which is as really a marine, as the other is a fresh-water animal. This species seems to me to be undescribed by authors and very distinct from the *M. piscinus* of *Linnæus*, which it in some measure resembles. In a few hours after a salmon has entered the river, not one of these MONOCULI are to be found upon it. *Quære*,—Have we not in these *vermes* a provision made by the Author of Nature for forcing the salmon from the sea into our rivers, and from the rivers back again into the sea?

[1] Br. Zool. iii. 4to ed., p. 252.

Inherited Memory

YOUR correspondent "A. B." has propounded a theory which would satisfactorily explain a good many facts in natural history which have hitherto been extremely perplexing. I am strongly inclined to believe that in some of our birds, at any rate, the knowledge of localities is inherited. About thirty years ago I lived at a farmhouse, my father's home; the house stood alone in the country; my father also occupied some premises in a village, about half a mile distant. On these premises there was a large, very old dove-cot containing blue rock pigeons.

My brothers and I wished to establish a similar dove-cot at the farm, and prepared a suitable room for the purpose. In the first instance we caught, one winter's night, about fifty of the old rock pigeons; these we confined for five or six weeks, but when liberated they of course flew straight home. We next took a number of fledged young ones out of the nests. These had never been outside the old dove-cot, but when sufficiently strong they all flew away, as the old ones had done.

Discouraged, but still determined to succeed, we next bought a number of tame pigeons, and when they began to sit we put eggs of blue rocks under them, taking their own eggs away. Several were reared; but as soon as they were strong enough to dispense with the care of their foster-mothers, they one after another deserted them and returned to the ancestral dove-cot. A few years after this the premises where the old dove-cot was situated were altered, and the way into the dove-cot quite stopped up. The pigeons were sold and driven away.

For nearly twenty years blue rocks continued to visit the old premises. Some of them built on a ledge in an old gateway, that being the place in which it was possible for them to find nest-room the nearest to the old dove-cot. These occurrences seem to point to remembrance of localities in the race as well as in individuals, and "inherited memory" would, I think, best account for *all the facts* of the case. JAMES ELLIS

The Gynsills, Leicester

A Golden Eagle and a Decoy—Audacity of a Hawk

WHILST staying a few days at Manhattan, a little town in Kansas, I spent some hours in the office of a dentist, Dr. C. Blackley, who is also an ornithologist, having stuffed a goodly number of the birds of the state. He was then occupied with a fine specimen of the common pelican (*Pelicanus communis*) one of a flock of over a thousand that passed over the town in the month of April, some of them alighting in the neighbouring marshes. These birds are not unfrequent visitors to these far inland regions, and I have known them shot and brought to me from the alkali lakes in Colorado, both regions from 600 to 800 miles from the sea. The doctor told me an amusing incident of a day's wild goose shooting in the vicinity. He took with him to one of the ponds frequented by wild geese, a stuffed specimen of the Canada goose, to act as a decoy. Having firmly planted his bird in the sand with its wooden platform well covered over, he lay behind the bushes awaiting a shot. Suddenly there was a rush of wings, and like a flash of lightning a golden eagle swept down on the decoy, knocking the bird over, and tearing out some of the stuffing. The eagle then sat down near his prey, staring with amazement at its remarkably quiescent character, as well as at the strange wooden appendage attached to its claws. Deeming there was something uncanny about such a goose, and there might be danger in the neighbourhood, he prudently flew away. Unfortunately a branch of a tree prevented the sportsman from shooting the marauder.

(I can vouch for the truth of this story; the doctor showed the goose and where it had been struck).

A few days after this, when in the village of Morrison, Colorado, I was struck with the audacity of one of our smallest hawks. I was standing on a lumber pile in the middle of the street, when I heard a scuffling of wings, and a squeaking; the latter proceeded from a small prairie squirrel, about the size of a rat, who was making the best of his way to a hole in the lumber, hotly pursued by a tiny hawk, whose body was no larger than that of his prey. The squirrel just escaped into the hole by the tip of his tail, the hawk unable to stop the impetus of its onset, dashing right against the lumber-pile, within six feet of where I was standing. I jumped down in pursuit, but totally regardless of my presence, the plucky little bird made another swoop at his prey, who had again made a sally from another hole. I knocked the hawk down this time with my hat, and the squirrel escaped under the wood pile. This took place in the centre of a little village street, with bystanders within a few yards of the occurrence.

The hawk resembled the female sparrow-hawk (*Falco sparverius*). A. LAKIS

School of Mines, Golden City, Colorado

INTELLECT IN BRUTES

NOW that the discussion on this subject in NATURE seems to be running dry, perhaps a few concluding remarks by one who has not hitherto taken any part in it may be admitted.

The discussion was started by Mr. Nicols recording a case of the gnawing of water-pipes by rats. This is not at all an unusual thing for rats to do, and I cannot see that the fact of their doing so, in order to obtain the water, would imply so incredible an amount of sagacity as some of the other writers in NATURE appear to suppose. The water can be heard within the pipe, and if the rats are thirsty, it seems a sufficiently simple device to gnaw the pipe. Of course it may be an open question whether they gnaw the pipe for this purpose, or for the mere sake of gnawing, or for any other purpose; but that a rat should have sufficient intelligence to gnaw through a water-pipe, supposing the animal to require water obtained in this way, I think there can be no doubt.

The discussion was enlivened by Mr. Henslow introducing certain general propositions as to the features wherein animal intelligence differs essentially from human, and it

is upon this topic that I should now like to offer a few remarks.

Although Mr. Henslow has not been very fortunate in the expression of his views, I think he has before his mind the most essential, as well as perhaps the most conspicuous, quality wherein animal intelligence differs from human. He says: "It has always seemed to me that brute reasoning is always *practical* and never *abstract*. They do wonderful things suggested by the objective facts before them, but, I think, never go beyond it. Thus, a dog left in a room alone rang the bell to fetch the servant. Had not the dog been taught to ring the bell (which, on inquiry, proved to have been the case), it would have been abstract reasoning, but it was only practical. The Arctic fox—too wary to be shot like the first who took a bait tied to a string, which was attached to the trigger of a gun—would dive under the snow, and so pull the bait down below the line of fire. This is purely practical reasoning; but had the fox pulled the string first out of the line of fire *in order* to discharge the gun, and *then* to get the bait, *that* would have been abstract reasoning which he could not attain to."

To this Dr. Rae replies: "To pull the bait downwards *out of the line of fire* was the only safe way for the fox to have acted. . . . . Had he used what Mr. Henslow calls 'abstract reasoning'—which, I presume, means pulling the bait, not the line, to *one side* out of the line of fire—the fox would certainly have been shot, as the bait could not have been moved more than four or five inches from the wooden stake through which the bait-line passes.

"If Mr. Henslow really means that the fox should have shown his powers of 'abstract reasoning' by going up to the line of fire between the gun and the bait, and then pulled the string until the gun went off, I think the chances of reynard's ever eating the bait would be very small indeed. I have known him do what showed equal or greater intelligence, namely, cut the bait-string, as already mentioned."

It having been thus clearly shown that the "practical reasoning" of the fox was more to the point than the "abstract reasoning" of his critic, and several others of your correspondents having supplied more or less well-authenticated instances of the display of deliberative reasoning by brutes, Mr. Henslow concluded his part in the correspondence by modifying his original statement thus:—"I will abandon my notion of abstract reasoning, at least as hitherto described, for I now think that what I meant by the want of the faculty would be better described as an impotence, or, at least, a feebleness of mind in concatenating correlative ideas; or, perhaps, a want of receptivity of the suggestiveness of things will express my meaning." Owing, perhaps, to a feebleness of mind in concatenating correlative ideas, or perhaps to a want of receptivity of the suggestiveness of things, for my own part I cannot perceive these words to express any meaning at all—or, at least, any meaning that is not flagrantly absurd. I have never known an animal unable to concatenate the idea of eating with the correlative idea of the thing suited to be eaten, and very few among the higher animals show any want of receptivity of the suggestiveness of such a thing as a whip. The truth is Mr. Henslow has only darkened his meaning by this latest multiplication of words. What he originally intended to say is, not that animals do not possess *any* power of abstract thinking, but that this power is in them feeble as compared with what it is in man. Abstract thinking means thinking in or of abstractions, *i.e.*, of qualities as apart from particular objects. Now it would be absurd to maintain that no animal has any idea of quality except as in association with particular objects of past experience. Give a cat or a dog some kind of meat or cake which the animal has never before met with, and the careful examination which the morsel undergoes before it is consigned to the mouth proves that the animal has properly abstract ideas of sweet, bitter, hot, nauseous, or, in general, good for eating and bad for eating, *i.e.*, abstract ideas of quality as apart from the object examined—the motive of the examination clearly being to ascertain which general idea of quality is appropriate to the particular object examined. Thus Mr. Henslow cannot mean that animals possess no power at all of abstract thought. What he must mean is that this power is manifested in an extremely undeveloped form, the mind of an animal being only furnished with abstract ideas of the simplest or least elaborated type, and being therefore unable to carry on for any considerable distance the process of forming and joining ideas irrespective of suggestions supplied by immediate sense-perceptions. In other words, as Mr. Henslow himself very clearly states the case in one of his earlier letters, "it is this *mental reflection* which seems to me to be wanting in animals."

Taking, then, this as the only meaning which Mr. Henslow has to convey, it is, I think, the only meaning which with philosophical justice he can have to convey. For the more that we push analysis into the region of brute psychology, the more do we become convinced that the only very considerable difference between it and human psychology consists in the comparatively small development of the power of "mental reflection."

And here I may remark that this is just the difference which the theory of descent would lead us to anticipate as the chief, if not the only, difference; for it is evident that this difference has reference to the highest qualities of mind—*i.e.*, those most removed from simple mechanical responses to stimuli supplied by the senses—and therefore to the qualities which must have been of the most recent development. The tree psychological has been a long time in growing; its roots are constituted by mere excitability, reflex action is its stem, its branches are the association of ideas, the emotions are its leaves, and the faculty of abstract thought is a single blossom borne upon its topmost spray. And if we compare this tree with that of zoology, we find that the single blossom of the one corresponds with the highest product of the other. *Homo sapiens* is the lord of creation, because, having sprung from the primates he started with some little power of abstract thought, which, through the instrumentality of continuously improving language, was forced on by natural selection at a probably astounding pace.

So far, then, as the theory of descent is concerned, there is no serious difficulty presented by this chief point of difference between animal and human intelligence.[1] I think, however, that both in this connection, and also for the sake of comparative psychology, it is desirable to say that although Mr. Henslow has, in my opinion, stated the only great difference that obtains between human and animal psychology, there is no reason to think that this difference is so great or absolute as he appears to suppose.[2]

[1] I may here remark that a great deal too much stress seems to me to be laid by many writers on the presence of self-consciousness in man as a feature distinguishing his mind from that of animals. For this faculty, it seems to me, is obviously one that *must* arise so soon as the power of forming abstract ideas has advanced sufficiently far to admit of an animal thinking of itself as distinct from its surroundings. And this is surely not any so enormous an advance as to be impossible without supernatural assistance. A semi-human animal might well have had an abstract idea of thou, you, and they, and also an abstract idea of its own body as being more or less similar to that of its fellows. From this to an abstract conception of I, as distinguished from thou and not I, the transition seems sufficiently easy; and when once the idea of self began to dawn, it would be assisted by reflection, rendering past states of consciousness objective to present ones. But the idea of self *plus* the power of introspection is all that can be meant by self-consciousness.

[2] In saying that Mr. Henslow has stated this difference to be the only one that obtains between human and animal psychology, I do not forget the remarks with which he concludes his correspondence. These remarks may be summed up in his own words—animals "cannot be self-conscious, cannot conceive of God, and can neither be moral nor immoral." As all these distinctions between human intelligence and animal intelligence clearly rest upon, or are included in, the distinction above considered in the text, it is needless to occupy space with considering them in detail. Although I have myself maintained that on the theory of evolution we might antecedently expect the more intelligent and sympathetic of the higher animals to present the germs of a moral sense, and further, that in the case of dogs this expectation seems sometimes to be realised, this, of course, is a widely different

Several of the instances which your other correspondents supplied, would, as Mr. Henslow himself admits, "if correctly stated, and *if the motive* of the animals could in every case be proved, completely overthrow my supposition that animals never copy us with the same or a rational purpose." And even if we allow, for the sake of argument, that none of these instances have been "correctly stated," yet there are such a multitude of other instances on record of substantially the same kind, that it is impossible to doubt that animals present the beginnings of "mental reflection." Not to occupy too much space, I shall confine myself to stating a few instances which have not hitherto been put on record. Mr. Henslow says, "Why is it that no dog ever (to my knowledge, of course) observed a person ring a bell, noticed that the bell brought the servant, and then went through the process of reasoning—'Because such was the result I will ring the bell too?' This I call abstract reasoning." Well, Mr. Lawson Tait tells me that he has a cat which, without having been taught, does precisely what is here imagined. That is to say, when the cat wants milk and cannot persuade the persons in the sitting-room to supply her wants, she touches the bell, with the evident purpose of attracting attention to her wants in a more emphatic manner. The animal must have observed that ringing the bell has the effect of calling the servant, who sometimes brings milk, and therefore when her solicitations are unheeded or misunderstood, she makes a sign which conveys her meaning more conspicuously and more explicitly than she is able to make with her voice. Although this is no doubt a very remarkable case,[1] it is really only a higher manifestation of the faculties of observation, reflection, and communication by signs, which in lower degrees are met with in many animals. Thus, I myself had a terrier which used to express all his desires—even the sexual—by the same sign, that of "begging;" but he was able to make this general sign of desire express the particular thing desired by the manner in which he performed the sign. Thus, for instance, if he wanted water, he used to go to a wash-hand stand, or other place where he had observed that water was kept, and beg with his face towards the water-jug. I adduce this instance because, while it involves the manifestation of the three faculties above-named, it does so in a comparatively low degree, and therefore serves a stepping-stone to their higher manifestation in such instances as that of Mr. Tait's cat. There is nothing so very extraordinary in a dog observing that water is frequently poured out of a certain jug, and reflecting, "I can make my thirst known to my master by begging towards the jug." Yet this involves the same faculties of mind as does the ringing of a bell for a servant as a sign for desiring milk—the only difference between the two cases consisting in the more direct nature of the association and rational sign, Water, Water-jug, Begging towards water-jug, than of the association and rational sign, Milk, Servant a milk-bearer summoned by bell-pulling, Pulling bell to summon servant. Thus, so long as we have abundant evidence of the presence in animals of the faculties of observation and reflection in a low degree, we need not, as evolutionists, be over-solicitous to meet with the presence of these faculties in a higher degree, although as a matter of comparative psychology it is of interest that the highest degree to which such faculties attain in various species of animals should be ascertained. Among the instances which have been published in NATURE, perhaps the most remarkable is that communicated by Dr. Frost—the case, I mean, of the cat sprinkling crumbs to entice birds. I would suggest that Dr. Frost ought to supply more particulars as to where the cat obtained the crumbs, whether or not she had to carry them, and if so, to what distance, how she scattered them, and generally to furnish all the information that he can. So extraordinary does this case appear, that it ought to be stated with all possible minuteness. I have indeed met with alleged cases of precisely similar ingenuity—one displayed by a fox, another by a bear, and so on; but some well-observed instance is required to render these similar instances in any degree credible. Dr. Klein has told me of a case which resembles that of Dr. Frost's cat up to a certain point. For Dr. Klein satisfied himself that the cat he observed had established a definite association between crumbs already sprinkled on the garden-walk and sparrows coming to eat them; for as soon as the crumbs were sprinkled on the walk the cat used to conceal herself from the walk in a neighbouring shrubbery, there to await in ambush the coming of the birds. The latter, however, after all, showed themselves more wideawake than the cat, for there was a wall running behind the shrubbery, from the top of which the birds could see the cat in her supposed concealment, and there a long line of sparrows used to wait, watching the cat and the crumbs at the same time, but never venturing to fly down to the latter until the former, wearied with waiting, went away. In this case the observation and reasoning of the cat—Crumbs attract birds, therefore I will wait for birds where crumbs are scattered—was as complete as in the case of Dr. Frost's cat; but the reasoning in the latter case seems to have proceeded a stage further—therefore I will scatter crumbs to attract birds. And just because it is so rare a thing to find an animal taking this further step in reasoning—the step, I mean, from passive expectation to active adjustment—I think that Dr. Frost ought to be requested to supply more detailed information.

As further evidence of "mental reflection" by animals, I may give a few additional instances.

thing from supposing a dog to be either a moral agent or a religious animal. No one with an atom of common sense could entertain such a supposition for a moment; for morality and religion are among the highest products of abstract thought. Some time ago I had to give a lecture on evolution at one of our large provincial towns. Next Sunday the vicar told his congregation that there could be no truth in the modern doctrine, and the reason he gave had the merit of being boldly startling. "No one," he said, "had ever seen an ape pray." The answer to this profound argument is, that if any one ever did witness such a spectacle, the fact would deal the heaviest of possible blows against the theory of descent in the domain of psychology. A religious monkey would be a phenomenon impossible to explain by any scientific theory, so that—mimicry apart—if a naturalist were to see an orang outang kneel down, clasp its hands, and raise its eyes to heaven, he could only conclude that the animal was divinely—or diabolically—inspired.

[1] On reading the proof of this article, it seemed to me desirable to obtain more full information concerning this case, and, accordingly, I wrote to Mr. Tait to furnish it. The following is extracted from his reply:—

"The cat, a female, white, yellow eyes, absolutely deaf to all sounds not conveyed through solid media, was remarkably acute in the matter of sight, and singularly intelligent, being a granddaughter of my begging cat." [This was a cat which *spontaneously* adopted the habit of begging for food, and transmitted the habit to her kittens, and her kittens' kittens. I have seen one of these, now grown into a cat, which begs quite as well as any terrier; and the interesting fact is that all this family of begging kittens take to begging spontaneously, independently alike of teaching and of seeing their mothers beg.] "When in the room with Mrs. Tait and myself, and feeling a desire for milk, she first expressed that desire by peculiar cries, then by sitting in front of us and begging like her grandmother, but not in such an accomplished manner. This failing, she would go to the side of the fire-place, and, standing on a foot-stool, would pat with her hand the knob of the fire-place bell." [Of course, a cat, not having a properly prehensile hand, could not actually ring such a bell.] "This was never resisted, and as soon as she saw the bell rung, she went towards the door at which the servant would enter, and then waited in perfect confidence for the milk which she brought She did not attempt to leave the room with the servant, but waited patiently for her second coming.

"This cat was also remarkable as a fisher. She would wade into a small pond up to the shoulder and catch fish—trench, goldfish, minnows, &c.—always fond of dabbling in water."

I may here observe that cats seem to be more intelligent than dogs, at least in understanding special mechanisms. Thus it is not an unusual thing for cats, while it is an unusual thing for dogs, to ask admittance to a door by standing up on their hind legs and rattling the handle of the door with their fore-legs. Also, among the immense number of letters that I have received on the subject of animal intelligence, there is no one case narrated of a dog, while there are several cases narrated of cats jumping at knockers on street doors in order to obtain admission to their masters' houses. Similarly, I have only received one instance of a dog, while I have received several instances of cats jumping at thumb-latches for the purpose of opening the doors which the latter fasten. I myself had a cat which was constantly in the habit of entering the stables in this way. She used to spring at the handle below the latch, and, while holding on to the handle with one fore-paw, depress the latch with the other, and kick the door-post with her hind-legs in order to push the door open while she held the latch down. This complicated action can only be explained by supposing that the cat observed how her human friends manipulated a thumb-latch, reasoning that she might do likewise, and experimenting until she succeeded.

At the Zoological Gardens I have seen a small monkey hold out to me a nut to crack which was too hard for him to crack himself, and the conflict of emotions with which he held out, again withdrew, and eventually surrendered his treasure was positively painful to witness. Of course I cracked the nut, and Prof. Huxley tells me that he once performed a similar act of charity under precisely similar circumstances. Now the process of "mental reflection," which led to this surrender by the monkey of his valued property must have been both vivid and complex.

Although I have never myself observed an instance, I can have no doubt from the concurrent and independent testimony which I have received that dogs are sometimes capable of reasoning thus: Is my master out or not? When he goes out he always takes his great-coat with him; therefore I will go and see whether or not his great-coat is hanging in its accustomed place.

Lastly, I have just received a letter from the Vicar of Carn, which relates an instance of mental reflection on the part of a poodle dog that has the merit of admitting neither of mal-observation nor unconscious exaggeration. The vicar's friend—a Canon whose name I have at present no express permission to publish—went to visit a cousin, who owned the poodle dog. I will conclude by telling the rest of the story in my correspondent's own words: "The poodle, whose name is Mori, went into the dining-room with them, and kept quietly under the table till the end of lunch, when he begged for a little food, and he was given a small shred of beef. They returned to the drawing-room, while the servant cleared away, and the beef was taken into the larder. The dog did not think he had had his fair share. . . . Now, he had been taught to stand on his hind legs, put his paw on a lady s waist, and hand her into the dining-room. He adopted the same tactics with my friend the Canon, ... but the sagacious dog, instead of steering for the dining-room, led him in the direction of the larder, along a passage, down steps, &c., and did not halt until he brought him to the larder, and close to the shelf where the beef had been put." [After giving him a piece of beef, the Canon went upstairs and refused again to be led down as before.] "Finding he could not prevail on the visitor to make a second excursion to the larder, he went out into the hall, took in his teeth Canon ——'s hat from off the hall table, and carried it under the shelf in the larder, where the coveted beef lay out of his reach. There he was found with the hat, waiting for its owner, and expecting another savoury bit when he should come for his hat."

GEORGE J. ROMANES

NOTES ON THE FAUNA OF THE SOLOMON ISLANDS

At a late (January, 1879) meeting of the Linnean Society of New South Wales Mr. E. P. Ramsay, F.L.S., &c., read a paper on the Zoology of the Solomon Islands, the subject of this paper being a large collection of mammals and birds collected at Gaudalcana, Savo, and Cape Pitt by Mr. James Cockerell, a well known Australian collector. The collection was obtained from Capt. Brodie, of the schooner *Ariel*, who had made arrangements with Mr. Cockerell to collect in the islands. Among the novelties described we find two species of Monarcha: (1) *M. barbata*, with elongated black plumes from the throat, belonging to the *M. loricata* and *M. leucotis* section; (2) *M. rufocastanea*, black above, deep chestnut rufous below; (3) a Sauloprocta, *S. cockerellii*, black above and as far as the breast, which is striped with white and with the abdomen and under tail-coverts white; two species of Myiagra, (4) *M. ferocyanea*, of a beautiful clear steel-blue black above and on the throat, the remainder of the under surface white; (5) *M. pallida*, ashy blue above, white below, tail chiefly pale rufous; (6) a fly-catcher, allied to *Rhissidura rufifrons*, but distinct in being smaller and having much more rufous on the head and less on the tail, has been named *R. rufofronta*; (7) a curious little sun-bird, *Cinnyris melanocephalus*, having a black head and the remainder of the body dull olive yellow above, brighter yellow below; (8) a Pseudorectes, of a rich cinnamon colour, with whitish throat, and yellow crissum and ochre-yellow under tail-coverts, is called *P. cinnamomeum*; and (9) a Calornis of a uniform bright steel-green colour, with a sharply ridged keel-shaped culmen, but otherwise resembling *C. cantor*, is named *Calornis solomonensis*.

In addition to the new species, the collection contained some of great interest to ornithologists, particularly a beautiful series of the rare *Lorius cardinalis*, and *Halcyon leucopygia*, of which the female only was previously described. A var. of *Halcyon chloris* is also described, which differs from Mr. Sharpe's plate (Sharpe, "Monog. Alced.," pl. 87) in having the whole of the under surface rich buff, the under wing-coverts of a deeper tint. There is also a large series of *Megapodeus brenchleyi* (Gray), adults and young, and quite a number of *Dicæum erythrothorax*. Among the pigeons *Carpophaga rufigula* (Salvad.) is conspicuous from its peculiarly formed cere, also another large species allied to or identical with *C. van-wickii* (Cass.). A var. of (?) *Ptilopus viridis* is described, also *P. superba* from the same place.

The following is a complete list of the species recorded and their habitats:—

		Locality.
1.	*Astur soloensis*	Cape Pitt.
2.	*Baza stenozoa*	Gaudalcana.
3.	*Ninox* ,,	,,
4.	*Cacatua ducorpsii*	Savo.
5.	*Lorius cardinalis*	Savo and do.
6.	,, *chlorocercus*	,,
7.	*Geoffroyius heteroclitus*	,,
8.	*Eclectus polychlorus*	,,
9.	*Centropus milo*	Gaudalcana.
10.	*Cuculus taitensis*	Savo.
11.	*Chalcites plagosus* (?)	,,
12.	*Eurystomus crassirostris*	Cape Pitt
13.	*Eulobes kreffiii*	,,
14.	*Calorius metalica* (?)	Savo.
15.	,, *solomonensis*, sp. nov.	,,
16.	*Sturnoides fulvipennis*	Gaudalcana.
17.	*Graucalus hypoleucos*	,,
18.	,, ,, sp. nov.	,,
19.	*Edoliisoma* (*? plumbeum*)	,,
20.	*Tachycephala orioloides*	,,
21.	*Pseudorectes cinnamomeum*, sp. nov.	,,
22.	*Monarcha barbata*, sp. nov.	,,
23.	,, *rufocastanea*, sp. nov.	,,
24.	*Sauloprocta tricolor*	,,
25.	,, *cockerelli*, sp. nov.	,,
26.	*Rhissidura rufofronta*, sp. nov.	,,
27.	*Myiagra ferrocyanea*, sp. nov.	,,
28.	,, *pallida*, sp. nov.	,,
29.	*Cinnyris melanocephalus*, sp. nov.	,,
30.	,, *frenata*	,,
31.	*Dicæum erythrothorax*	,,
32.	*Halcyon leucopygia*, Ven.	,,
33.	,, *chloris*, var.	Cape Pitt.
34.	,, *sanctus*	Savo, &c.
35.	*Carpophaga rufigula*, Salvad.	,,
36.	,, *van-wickii*, Cass.	Gaudalcana.
37.	*Ptilopus viridis*, var.	,,
38.	,, *superbus*, Temm.	,,
39.	*Chalcophaps chrysochlora*, var.	,,
40.	*Macropygia* ,,	Savo.
41.	*Megapodius brenchleyi*	,,
42.	*Butoroides javanica*	,,
43.	*Herodias garzetta*	,,
44.	*Sula personata*	,,
45.	*Sterna bergerii*	,,
46.	,, *gracilis*, Gould	,,

In addition to the birds Mr. Cockerell obtained in quantity two species of Pteropus, two varieties or perhaps species of Cuscus, a species of Harpyia, a new Chiero-

pteruges, and a Macroglossus, also a species of Scotophilus, probably *S. nigrogriseus*, Gould.

The fishes were not numerous, but some interesting species were obtained, respecting which the Hon. Wm. Macleay read some remarks which will be published in due time.

The insects, about fifty species, will also we hope be taken up by Mr. Macleay. Among the spiders are some very interesting forms, apparently quite new.

The collection of birds numbers about 350 specimens, the mammals about 120. Spirit specimens about 100.

We believe a large portion of this fine collection has been secured by the curator, Mr. E. P. Ramsay, F.L.S., for the Australian Museum.

THE SORTING DEMON OF MAXWELL[1]

THE word "demon," which originally in Greek meant a supernatural being, has never been properly used to signify a real or ideal personification of malignity.

Clerk Maxwell's "demon" is a creature of imagination having certain perfectly well-defined powers of action, purely mechanical in their character, invented to help us to understand the "Dissipation of Energy" in nature.

He is a being with no preternatural qualities, and differs from real living animals only in extreme smallness and agility. He can at pleasure stop, or strike, or push, or pull any single atom of matter, and so moderate its natural course of motion. Endowed ideally with arms and hands and fingers—two hands and ten fingers suffice—he can do as much for atoms as a pianoforte player can do for the keys of the piano—just a little more, he can push or pull each atom *in any direction.*

He cannot create or annul energy; but just as a living animal does, he can store up limited quantities of energy, and reproduce them at will. By operating selectively on individual atoms he can reverse the natural dissipation of energy, can cause one-half of a closed jar of air or of a bar of iron to become glowingly hot and the other ice-cold; can direct the energy of the moving molecules of a basin of water to throw the water up to a height and leave it there proportionately cooled (1° Fahr. for 772 feet of ascent); can "sort" the molecules in a solution of salt or in a mixture of two gases, so as to reverse the natural process of diffusion, and produce concentration of the solution in one portion of the water, leaving pure water in the remainder of the space occupied; or, in the other case, separate the gases into different parts of the containing vessel.

"Dissipation of energy" follows in nature from the fortuitous concourse of atoms. The lost motivity is essentially not restorable otherwise than by an agency dealing with individual atoms; and the mode of dealing with the atoms to restore motivity is essentially a process of assortment, sending this way all of one kind or class, that way all of another kind or class.

The classification, according to which the ideal demon is to sort them, may be according to the essential character of the atom; for instance, all atoms of hydrogen to be let go to the left, or stopped from crossing to the right, across an ideal boundary; or it may be according to the velocity each atom chances to have when it approaches the boundary: if greater than a certain stated amount, it is to go to the right; if less, to the left. This latter rule of assortment, carried into execution by the demon, disequalises temperature, and undoes the natural diffusion of heat; the former undoes the natural diffusion of matter.

By a combination of the two processes, the demon can decompose water or carbonic acid, first raising a portion of the compound to dissociational temperature (that is, temperature so high that collisions shatter the compound molecules to atoms), and then sending the oxygen atoms this way, and the hydrogen or carbon atoms that way; or he may effect decomposition against chemical affinity otherwise, thus: Let him take in a small store of energy by resisting the mutual approach of two compound molecules, letting them press, as it were, on his two hands, and store up energy as in a bent spring; then let him apply the two hands between the oxygen and the double hydrogen constituents of a compound molecule of vapour of water, and tear them asunder. He may repeat this process until a considerable proportion of the whole number of compound molecules in a given quantity of vapour of water, given in a fixed closed vessel, are separated into oxygen and hydrogen at the expense of energy taken from translational motions. The motivity (or energy for motive power) in the explosive mixture of oxygen and hydrogen of the one case, and the separated mutual combustibles, carbon and oxygen, of the other case, thus obtained, is a transformation of the energy found in the substance in the form of kinetic energy of the thermal motions of the compound molecules. Essentially different is the decomposition of carbonic acid and water in the natural growth of plants, the resulting motivity of which is taken from the undulations of light or radiant heat, emanating from the intensely hot matter of the sun.

The conception of the "sorting demon" is purely mechanical, and is of great value in purely physical science. It was not invented to help us to deal with questions regarding the influence of life and of mind on the motions of matter, questions essentially beyond the range of mere dynamics.

The discourse was illustrated by a series of experiments.

[1] Abstract of Lecture at the Royal Institution, Friday, February 28, 1879, by Sir William Thomson, LL.D., F.R.S.

PAOLO VOLPICELLI

THIS eminent Italian physicist, whose death we recently recorded, was born at Rome on January 8, 1804. He lost his mother a few days after his birth; his father was Prof. Alexander Volpicelli, a member of the Medical College of the Roman University. Paolo was educated at the college of Veroli and the University of Rome, where, in accordance with the wish of his father, he commenced the study of medicine, but abandoned it after the first year, declaring that medicine was not a science. Of his own accord he applied himself seriously to the course of mathematical philosophy, and four years later received the degree of doctor *ad honorem* in that faculty. It should be mentioned that doctorates *ad honorem* are given to only two students each year, and Volpicelli's fellow-doctor was the eminent Professor Tortolini, who followed the same course. Before leaving the University his professors recommended him to the Government for a scientific position. In fact, Prof. Morichini wished to name him his successor to the Chair of Chemistry in the University of Rome, but Volpicelli preferred to succeed Dr. Barlocci, Professor of Experimental Physics in the same University, and in 1845, on the death of Barlocci, became titular professor. Volpicelli occupied this chair till 1873, when he was appointed Professor of Mathematical Physics in the same University. In 1851 he was made a member of the Philosophical College, an honour accorded to only twelve professors of the University of Rome. Besides his position at this University, Volpicelli also filled that of Professor of Mathematical Physics at the Roman Seminary, taught geometry to the pupils of St. Michael's Hospital, and founded at Rome the special School of Artillery, of which he was director for thirty years.

When Pope Pius IX. revived the celebrated and historical Lincei Academy in 1847, Volpicelli was appointed secretary, a post which he held for thirty years, when, as his health was failing, the academicians made him secre-

tary *emeritus*. By his tact and energy at the time of change of government at Rome, he was enabled to save the Archives of the Academy, of which during his lifetime he was one of the most active members.

Volpicelli was well known abroad, and the Emperor of Brazil when in Rome spent some time with the professor, and conferred upon him the grade of officer of the Imperial Order of the Rose. Volpicelli travelled much, and in 1850 he made a long stay in England, where he made the acquaintance of Faraday, Brewster, Airy, Murchison, Sabine, Panizzi, Wheatstone, and others, with whom he afterwards continued to correspond. In France and Switzerland also, he was the friend of the most eminent men of science.

Volpicelli was an energetic worker in his favourite field of electrical research, and to the last maintained with vigour the theory of Melloni, at which he had worked for twenty years. The papers and other works published by Volpicelli were very numerous; no less than 270 are enumerated in a list published by the Academy dei Lincei. Although he is chiefly known by his researches in electricity, these papers show that he did much other work in various departments of mathematics and physics. Volpicelli's papers will be found mainly in the *Atti de l'Accademia dei Lincei*, and the *Comptes Rendus* of the Paris Academy. Very few of them have, however, been translated into English, a circumstance which must be regretted for the sake of English scientific men, to many of whom Volpicelli's researches are known only by name. He died calmly on April 14, having been visited shortly before his death by the Pope's brother, Cardinal Pecci.

AN AMERICAN SUGGESTION

WE have occasionally noted in these columns the formation of mathematical societies, and we have ventured, in our ignorance, to suggest that as a consequence of the great advance in the cultivation of mathematics recently made by our American cousins, the time had come for the formation of an American or (following the analogy of associations nearer home) of a Baltimore Mathematical Society.

A short account of the *Proceedings* at the fifth meeting of the Lehigh Mathematical Society—recorded in the *Bethlehem Daily Times* (Pa.) for March 17—may interest kindred societies on this side the Atlantic, and serve to show that the transactions of such learned bodies may contain "something of importance and profitable (*sic*) to the general reader."

It appears that in order to remedy the defects in the art of surveying, it has been made imperative (so says Mr. S. R. Vay, Civil Engineer, the reader of the paper[1]) by the American legislature that "each county should at its own expense and on its own land, plant, or erect, two monuments of stone, so that the straight line between them should be an exact and due meridian, or north and south line; in order that thereby surveyors, by setting a compass on the one monument, and pointing it to the other, might readily ascertain the deviation or variation of the magnetic needle, and thus be prevented from committing errors in the determination of property lines and landmarks." His soul was much stirred at the neglect of this "scientific duty." It seemed to him that "the scientists of the valley ought to urge, with no uncertain voice, the erection of such or similar monuments. With but little extra expense they could easily be made to interest and to educate, as well as to serve the purpose designed by the legislature. Imagine, for instance, two beautiful granite monuments standing in appropriate situations on the spacious ground of Lehigh University, one mounted with a sun-dial, and the other with an anemometer. On one of them should be cut in plain letters the latitude, longitude, and elevation above the sea of that exact spot. On the other should be recorded a statement of the mean annual temperature and rainfall of the valley. The axis of the sun-dial would not only point to the steadfast pole, but be parallel to the earth's axis; it could, indeed, be furnished with a hoop or circle, to represent the equator, and with others to represent the meridians of Greenwich, Washington, and Bethlehem; a circle to indicate the ecliptic would not be difficult to add, which, by properly constructed clock-work should be always kept parallel to the real ecliptic itself. Thus all who might pass that way would be interested in reading the inscriptions and observing the time, and many would be instructed in the science of astronomy. Even to students it would be of benefit in lightening their mental struggles to grasp, conceive, and understand the idea of the ecliptic circle and the ecliptic plane."

[1] Touching first upon the necessity of preserving boundaries and upon the methods employed by the ancients; tracing the word geometry to its source, and relating how the Egyptians were puzzled to find their landmarks, he then passed on to the discovery of the magnetic needle, and the perplexity caused to country surveyors by the deflection of the same.

In the discussion which followed, the President doubted the wisdom of the legislature, and thought the better way would be to require higher qualifications from surveyors.

Dr. H. E. Licks inquired the expense of such a sun-dial as Mr. Vay had described.

Mr. A. S. Tronomy said "it was usual to consider the ecliptic as a fixed plane when illustrating the yearly motion of the earth. When considering the daily rotation, however, he could see that Mr. Vay's plan had some advantage."

The next paper was by Prof. Ternion, "On the consequences which would result from denying or reversing the tenth axiom of Euclid." The argument, we learn, was "elaborate and profound, being exemplified by long formulas written on the blackboard." He showed that "if the properties of matter or space were such that the axiom became false, a knot could not be tied in a string, that a hollow rubber ball could be turned inside out without tearing or stretching, and that no satisfactory system of paper or silver money could be employed."

Mr. K. M. Puter considered the paper as an example of mathematical analysis, one of very great value, but he considered it fortunate that we cannot practically reverse the axioms of geometry. "If we could, the results would be disastrous." Our notice of the *Proceedings* at this interesting meeting have extended to some length, but they may be suggestive of matter for societies on this side of the world. We cannot close, without alluding to another feature, and that is the subsequent proceedings (unscientific) before the members separated.

Crackers and cheese were brought forward and the knot untied by the Secretary "without denying any axiom whatever." "The mathematical joke and the hearty laugh were heard," and, tell it not in Gath, they sang a song. Of a Mathematical Society not a hundred miles off, the first President wrote, "not a drop of liquor is seen at our meetings, except a decanter of water; all our heavy is a fermentation of symbols; and we do not draw it mild. There is no penny fine for reticence or occult science; and as to a song! not the ghost of a chance."

THE STANDING STONES OF CALLANISH

THE object of the present paper is to describe the standing stones of Callanish, Island of Lewis, accompanied by notes of such measurements as the author was able to take during a somewhat hurried visit to these very interesting memorials of the early inhabitants of our islands.

Leaving the town of Stornoway, we soon find ourselves amongst great tracts of moorland, with sheets of water large and small on all sides. The deep black peat is being cut and piled up into stacks, when, after being dried, it will serve for the winter's fuel. The peats in the Lewis

are broad and thin, and not so brick-shaped as those on the mainland further south. All around wears a sombre aspect. Miles and miles of bog and moorland, without tree or bush to break the long undulatory lines which rise and fall like the waves of the sea.

At length, as we reach the top of a slight rise, we see before us the object of our visit, the stones appearing so thickly clustered together on the rising ground on which they stand, as to suggest the likeness to a cemetery. Leaving the vehicle a little beyond the sixteenth mile-

Plan of General Arrangement of Group.

stone from Stornoway, we ascend by a roughly causewayed roadway which leads from the main road to the top of the low hill upon which the stones are placed. On a closer inspection it is found that the general outline is cruciform, and at or near the intersection of the cross limbs is placed the largest stone, whilst around is a circle of tall stones. The stones are rough, and appear only to have received such dressing as would bring them to a suitable shape for erection; they are composed of the rock of the island, the Laurentian gneiss, which, in geo-

View from North-East.

logical record, is the oldest known. In colour it is greyish, with occasional flesh-coloured patches. The stones are monoliths, and are all upright.

The upper parts of the stones are covered with a greyish green lichen, the lower parts being comparatively bare. This is accounted for by the fact that a number of years ago the proprietor of the island caused the peaty ground around to be removed, which showed that the height was much greater than had at first appeared; the parts thus recently disclosed have not the heavy coating of lichen which the upper parts have; the line separating the two parts is very marked. From this the great age

of the stones may be inferred, as there has been an accumulation of peaty soil of about five feet deep.[1]

From a careful inspection of the stones the author found the number to be forty-eight. (The driver's remark on being asked the number was that they could not be counted over by different people and made the same.) The highest stone is about 16 feet, and the stones forming the circle are next to the central one in height, varying from about 8 feet to 11 feet. The others vary from about 7 feet to about 4 feet.

The longer limb of the cross is composed of two rows of stones placed about 27 feet apart, there being ten stones on the west side and nine on the east side. This is a very distinct feature in the arrangement, as there is thus an avenue leading to the circle. The circle consists of thirteen stones, and the western and eastern cross arms have each a single line of four stones, whilst the southern limb is composed of six stones; the whole with the central stone and one outside and close to the circle makes forty-eight. The general arrangement will be more readily understood from the accompanying plan, which is drawn approximately to scale. From careful observations with a pocket compass, the general bearing of the northern limb was found to be 30° to east of magnetic north; it was also found that, when a line was projected from the flat side of the endmost southern stone, it cut exactly the end stone of the western side of the northern limb; the latter stone measures about 11 feet in height. If the compass variation be estimated at 25° west (the latitude is about 58° 12′ north), it appears that the main axis of the group lies about 5° to *east* of true or polar north. Several of the stones besides the one already mentioned appear to have a *directive* tendency, notably the one next the circle in the eastern side of the northern limb; this stone, both from its pointed shape and flat form, leads the eye to the centre of the circle. The whole series, indeed, are arranged with their narrow faces pointing in the line of setting; this is easily noticed, as the stones are generally flat, thin, and slab-like. The circle stones have their broadest faces turned to the centre of the circle. The great stone is situated at or near the centre of the circle; it measures about 16 feet in height, with a breadth at bottom of 5 feet, at middle of 4 feet, and upper part 3 feet 6 inches; its thickness is 1 foot; its flat side faces the east. This stone must weigh about six tons.

The general dimensions of the group are as follows:—

Extreme length, 128 yards; length of northern limb, 85 yards; diameter of circle, 14 yards (this measurement is in a north and south line; from east to west the measurements gave 13 yards, so that the figure is slightly elliptical); length of southern limb, 29 yards; extreme breadth, 44 yards; length of western arm, 13 yards; length of eastern arm, 18 yards. The whole figure roughly resembles the Iona cross in outline. In or near the centre of the circle there is a hollow, roughly rectangular on plan, measuring about 7 feet long, the breadth at centre being 6 feet, and at ends 5 feet, narrowing, however, at the eastern end, so as to form a kind of channel leading outwards. The sides of this hollow are built of small stones, and four large stones are placed so as to break up the whole into two chambers. The direction of length of this hollow is east and west; the tall central stone already described being situated near to and facing its western end. It is said that a stone cover was found upon this hollow when first discovered. The hill upon which the stones are placed slopes downwards to the north; the ground on which the cross arms are placed is about level.

[1] It is difficult to get reliable data as to the growth of peat-moss, but taking about 200 years to the foot, a depth of 5 feet would infer a period of about 1,000 years since the peat commenced to form. In Black's "Guide" it is stated that the stones rest on a causewayed base. As there was no trace of this at the time of the author's visit, seeing that there was a vegetable growth all around, some data as to rate of growth of the peaty soil might be got, as it is about twenty years since the excavation of the peat took place.

Another circle of tall stones still stands about a mile to eastward, from which it appears that the peat has been recently removed.

From an examination of the stone circles of Arran, the late Dr. Bryce found that stone cists in some cases existed at the centres of the circles, and that the longer lengths of these cists, as also the longer axis of one elliptically-shaped series of stones, were all lying about north and south, or inclining rather to east of north.

In the Smithsonian Report for 1876 there is a description of mounds and lines of stones in Guatemala, the long sides and directions of which were about 5° to west of magnetic north; they vary from 2 feet to 6 feet in height. This would leave, after allowing for the easterly variation of the compass there, a probable direction of 5° or 10° to east of true or polar north. A certain similarity, therefore, appears to exist in the setting out of these groups, with a tendency to a direction east of north.

The country people called the place Callanish, not Callernish, as sometimes given, the meaning of the former name having been defined as "place of assembly for worship," whilst the latter is given as "bleak headland."[1] The title Fir Bhreige, or false men, is sometimes given to the group, from the apparent motion of the stones as the spectator changes his position when viewing them from a distance.

The erection of such circles as that of Callanish has been popularly attributed to the Druids, and according to this theory the Callanish circle would have been a religious meeting-place. Again, it has been supposed that they were tombs of warriors, and may have been erected by the early Norse rovers. Others look upon such groups of stones as places for judicial meetings, which might have been accompanied by religious ceremonies. From some recent scientific investigations at Stonehenge it appears likely that the stones there were erected for astronomical purposes.

The general impression which one gets from standing amongst the Callanish stones is that the long avenue was intended as an approach from the not far distant shore for a large body of people, who would thus converge towards the central circle.

W. J. MILLAR

[1] See Smith's "Lewsiana."

OUR ASTRONOMICAL COLUMN

BIELA'S COMET IN 1879.—There have been suggestions as to sweeping ephemerides for the recovery of one or other portion of the disintegrated comet of Biela in the present year. It is not, however, easy to decide in what manner, or rather upon what assumptions, calculation can be brought to bear with the greatest chance of success. We know that in 1852 the observed positions of the two nuclei were such that they could be accurately connected with similar positions at the preceding appearance in 1846, by the application of the perturbations from known causes in the interim, and it is also certain that neither of the nuclei was in the calculated position at the next return but one in 1866, there having been no chance of finding the comet in 1859, from proximity of its geocentric track to the sun's place. In 1865-6 the comet was diligently sought for in and around the position it should have occupied by the elements of 1852, brought up to 1866 by the application of planetary perturbations during the two revolutions, with some of the most powerful instruments in our observatories, including the refractors at Pulkowa and Copenhagen. D'Arrest, after long search, was convinced that the comet, speaking collectively, could not have passed its perihelion within many days of the time predicted. The conclusion was inevitable that perturbation from some unknown cause must have taken place between 1852 and 1866, and that all clue to the future movement of the comet was for the time lost. In 1872 endeavours to find

the comet near its old track were equally unsuccessful, and it was not till the grand meteoric shower on the evening of November 27 in that year that further light was thrown upon the subject. As is well known, the meteors of that great shower were found to be moving in an orbit sensibly identical with that of Biela's comet in 1866. Intersecting, or at least passing very near to the earth's orbit on November 27, the comet must have been descending to a perihelion passage a month later, or about December 27·6; such at least would be the date when the meteoric shower would arrive at its least distance from the sun. In this fact appears the only ground upon which we can now work to obtain an idea of the probable position of the comet in the present year. If we apply Dr. Michez's perturbations from 1852 to 1866 to the late Prof. Hubbard's elaborately-determined elements of the south-following nucleus in 1852 (assumed to be identical with the principal comet in 1846), we find the following orbit for 1866:—

Longitude of perihelion	109° 39′ 48″	Mean equinox
,, ascending node ...	245 43 42	January 27.
Inclination to ecliptic	12 22 3	
Angle of excentricity	48 46 19·35	
Mean daily motion	529″·9157	
Revolution	2445·67 days.	

And bringing up the longitudes to the equinox of 1879 we have the following heliocentric co-ordinates to be combined with the X, Y, Z of the *Nautical Almanac* in the preparation of sweeping-ephemerides on different hypotheses as to time of arrival at perihelion:—

Time from perihelion.	*x.*	*y.*	*z.*
−50 days ...	+0·8145 ...	+0·7263 ...	+0·4119
40 ,, ...	0·6150 ...	0·7914 ...	0·3916
30 ,, ...	0·4041 ...	0·8379 ...	0·3621
20 ,, ...	+0·1755 ...	0·8593 ...	0·3218
−10 ,, ...	−0·0562 ...	0·8497 ...	0·2699
0 ,, ...	0·2855 ...	0·8053 ...	0·2070
+10 ,, ...	0·5025 ...	0·7261 ...	0·1352
20 ,, ...	0·6990 ...	0·6171 ...	+0·0578
30 ,, ...	0·8704 ...	0·4857 ...	−0·0218
40 ,, ...	1·0161 ...	0·3397 ...	0·1008
+50 ,, ...	−1·1379 ...	+0·1856 ...	−0·2510

If the meteoric cloud of November 27, 1872, was moving in the orbit given above, a revolution counted from December 27·6 in that year will bring us to about September 8, 1879, as the epoch of next perihelion passage. Assuming September 7·5 we should have the following sweeping-line for that date:—

Time from perihelion.	Right ascension.	North declination.	Distance from earth.	Intensity of light.
0 days ...	140°·2 ...	10°·8 ...	1·66 ...	0·47
−20 ,, ...	125·9 ...	17·4 ...	1·42 ...	0·57

It may, however, be regarded as by no means improbable that the perihelion passage of the body which caused the shower of meteors may take place much later, and a very close and extended search will be required.

Sweeping-ephemerides to the extent desirable would occupy too much space here, but they will be easily prepared in the manner indicated from the above co-ordinates.

It is impossible not to admit the justice of a remark made by M. Otto Struve at the Stockholm meeting of the German Astronomical Society, when urging further attention to this comet: "Kein Comet gebe mehr Ansicht, über die Natur der Cometen im Allgemeinen etwas zu erfahren, als der Biela'sche;" and if due preparation be made this year for an exhaustive examination of the heavens in those regions where it is possible any portion of the comet may be found, further light may be thrown upon what yet appear the mysterious agencies which have affected its constitution and motions.

GEOGRAPHICAL NOTES

IN the place of Prof. Geikie's lecture on geographical evolution which was promised for this month, the June number of the Geographical Society's monthly periodical contains the anniversary address by Mr. Markham on the progress of geography. This is followed by a short paper on the "Mardian Hills and the Lower Indravati in the Bustar Dependency," contributed by Capt. T. H. Holdich, R.E., who also furnishes a sketch-map of the region. As regards quantity, at any rate, the geographical notes show a great improvement on previous numbers, and many of them supply information of considerable interest. Attention may be especially called to Mr. Keith Johnston's remarks on the employment of elephants in African travel, and regarding his own movements, Russian topographical labours in the Kirghiz Steppe and in Turkistan, the Russian Trans-Caspian territory, recent topographical survey by the Russians from the Oxus to Herat, new maps of Afghanistan, and a singular cave-formation in Queensland. There is also a good summary of Lieut. Wheeler's survey work in Oregon in 1878, based on an account drawn up by Mr. T. W. Goad, who was himself an active partaker in the work. Under the head of "Proceedings of Foreign Societies," we find a report of the Inter-Oceanic Canal Congress up to May 23. The last thirteen pages of the number are occupied by notes on new books and maps.

MR. J. F. BROUMTON, the agent of the China Inland Mission at Kweiyang-fu, in the Kweichow province, recently accompanied Mr. Cameron, on his way from Yünnan to the sea-board, as far as Kweilin-fu, in Kwangsi. Their route lay through the regions occupied by the Miao-tsze, or aboriginal tribes, who are very numerous in the south-east of Kweichow, and practically independent of the Chinese. Mr. Broumton visited a place called Pa-tsia, near which there are many Miao-tsze, but they are very shy and do not mix with the Chinese, only coming to the town on market-days to buy cotton, cloth, salt, &c. Their villages consist of mud cottages, usually hidden among trees and situated in places among the hills, which are difficult of access. From what he saw, Mr. Broumton thinks that the Miao-tsze are thrifty and industrious, for their land seemed well cultivated and the people well clothed. There is another interesting class of people in the Kweichow province, viz., the Tsung-kia-tsze, who, it is thought, originally emigrated from Hunan and Kiangsi, and in course of time intermarried with the Miao-tsze. Now they are a distinct class, speaking a language differing from both the Chinese and the Miao-tsze. Like the latter, they do not bind their girls' feet, and they are described as a sturdy, hardy race and thriving agriculturists.

IN the annual statement of the British Museum, just presented to Parliament, we find a report by Mr. Major on the department of maps, charts, plans, and topographical drawings. We do not learn very much as to the nature of the accessions made during the year, but Mr. Major particularises a photographic reproduction of a hydrographical chart on parchment (dated 1385) in the Royal Archives at Florence, comprising the Atlantic as far as Cape Bojador, then the furthest point of geographical discovery southwards, to Syria and the Black Sea, on the east. On this chart, which is earlier by half a century than the effective discovery of the Azores by Diego de Sevill and other navigators, we find the islands of San Miguel and Santa Maria laid down, but with an illegible description, while the islands of San Jorge, Fayal, and Pico are described as Insule de Ventura and Columbia, and Terceira is named Insula de Brazi, so called from the Brazil wood with which it abounded, thus preceding its famous namesake in South America by a century and a quarter. The chart bears the following epigraph:—

"Gulielmus Solerij civis Maioricarum me fecit anno a Nat. Domini Mccclxxxv."

As considerable difficulty is often found in fixing the position of places in the interior of Australia, the following note of the distance in miles from Adelaide of each station on the overland telegraph line which terminates at Port Darwin on the northern coast, will be found useful:—Beltana, 355; Strangway Springs, 565; Peake, 636; Charlotte Waters, 804; Alice Springs, 1,036; Barrow's Creek, 1,207; Tennant's Creek, 1,354; Powell's Creek, 1,467; Daly Waters, 1,605; River Katherine, 1,771; Pine Creek, 1,825; Yam Creek, 1,854; Southport, 1,934; Port Darwin, 1,973. Considerable progress is being made with the trigonometrical survey of South Australia. We also learn that an exploring expedition from Queensland has just completed a flying survey across the northern portion of both colonies, large tracts of which are still practically unknown.

Excellent news from Abbé Debaise has arrived in Marseilles.

The Inter-Oceanic Congress has adopted, by 98 votes against 8, the proposal in favour of cutting the canal through the Isthmus of Panama, by the Bay of Limon, to Panama.

Dr. Miclucho Maclay, the Russian explorer, with an Italian, Chevalier Bruno, and Capt. Leeman, have sailed from Sydney for New Guinea, in the American schooner *Laddie*, F. Caller, chartered for a twelvemonth's cruise. 2,500*l*. has been spent on the equipment. The expedition is intended to be both scientific and commercial. New Caledonia, New Britain, and other islands are to be visited.

The first part of Dr. Nachtigal's new work: "Reisen in Afrika," comprising his journey across the desert to Bornu, is about to be published by Messrs. Wiegandt, Hempel, and Parey, Berlin.

A telegram from Gordon Pasha to the Italian Geographical Society, announces that Capt. Martini, the leader of the Italian expedition which is going to assist the Marchese Antinori, has obtained permission to enter Abyssinia, that he had left Œdowa, and had landed at Massanah.

THE FIRST OBSERVATIONS OF SUN-SPOTS

At p. 284 of Nature, vol. i., the following paragraph occurs:—

"Dr. Kirkwood commences by reminding us that the most ancient observations of sun-spots of which we have any record, are those of the Chinese in the year 321 A.D.; the first notice of their detection by Europeans being found in the *Annals* of the Frankish Kings. A black spot, according to Adelmus, was seen on the sun's disk March 15, 807, and continued visible eight days. Similar phenomena were again observed from May 28 to August 26, A.D. 840. The year 1096 was also signalised by the appearance of spots so large as to be visible to the naked eye. The next date, in chronological order, is that of 1161, when a spot was seen by Averröes. Finally, on December 7, 8, and 16, 1590, 'a great blacke spot on the sunne' was observed at sea by those on board the ship *Richard of Arundell*. The foregoing are, we believe, the only undoubted instances in which these phenomena were observed previous to the invention of the telescope."

During the winter of 1877-78 the late Mr. Mayers, Chinese Secretary of the British Legation in Peking, purchased on behalf of the British Museum a large Chinese Encyclopædia, comprising 5,020 volumes, and containing the most valuable information, historical, literary, and scientific. Unfortunately, however, its records end with the *Ming* dynasty, A.D. 1628. Whilst preparations were being made for its shipment to London, a sub-section of this immense work, entitled "Natural Phenomena," was placed at my disposal for purposes of research. I resolved to confine my attention to obtaining records (1) of the droughts and famines that had visited China, and (2) of the sun-spots observed by the Chinese.

The records of the droughts and famines are most minute. The years, months, and districts affected are given in detail.

With regard to sun-spots[1] [black spots on the sun[2]] I found that from B.C. 28 to A.D. 1617 fifty-six observations were recorded, and that ten other observations of what I have translated sun-shadows,[3] four of them prior to the first sun-spot observation, were mentioned. These observations are exhibited in the annexed table, from which it will be seen that undoubted sun-spots were visible in China on three occasions previous to the year A.D. 321—the date given by Père Mailla in his "Annales de la Chine"—namely, in the years A.D. 301, 302, and 307. The solar phenomena observed in 807 and 840 are also mentioned in the Chinese record.

The remarks regarding the apparent sides of the sun-spots, &c., are literal translations of the Chinese text.

Year.	Moon.	Remarks.
B.C. 28	3	Black shadows.
20	2	
A.D. 188	1	
300	1	
301	9	
302	11-12	
307	11	
321	2	
322	10	
342	1	
344	10	
345	3	
359	10	Size of an egg.
360	4	
361	2	
372	11	Size of a plum.
373	3, 11	Size of an egg.
388	2	Two spots; size of plums.
389	6	
395	11	
400	11	
499	2	Three spots; size of peaches.
501	8	
502	1-2	Two spots visible.
509	8	Black shadows.
510	2	" "
513	1-4	" "
577	11	
580	2	
807	10	
826	3	
832	3-4	
837	11	Size of an egg.
840	2	Black shadows.
841	11	
865	1	Black shadows.
874	—	
974	1	
1077	2	Size of a plum.
1078	1, 12	" "
1079	2	" "
1104	10	" date.
1105	10	
1112	4	
1118	11	Size of a plum.
1120	5	
1129	3	
1131	2	Size of a plum; visible four days.
1136	10-11	Size of a plum.
1137	2-4	" "

[1] See the *Journal* of the North China Branch of the Royal Asiatic Society for 1878: "Droughts in China, A.D. 620-1643," and "Sun-Spots and Sun-Shadows Observed in China, B.C. 28-A.D. 1617."

[2] This is a literal translation of the Chinese text.

[3] The Chinese character translated "shadows" may also be translated "breath," "vapour," &c.

Year.	Moon.	Remarks.
1138	2, 10	
1139	2, 10	
1145	6	Black shadows and spots.
1160	8	
1185	1	Size of an egg.
1186	5	" "
1193	11	
1200	8, 12	
1202	12	Size of an egg.
1204	1	" "
1205	4	
1238	10	
1276	—	Size of a goose's egg.
1370	—	Spots were frequently observed during this year.
1511	5	Black shadows.
1529	2	" "
1617	—	

ALEXANDER HOSIE

British Consulate, Canton, April 1

NATIONAL WATER-SUPPLY EXHIBITION

HYDE PARK and Trafalgar Square experiences have very plainly shown that the simplest way to induce a clamorous populace to forget what they fancy they want, is to let them hold their meetings and pass resolutions. It is a matter of such very small exertion to hold up a hand in favour of a resolution compared with taking any personal trouble to see that any steps are taken towards carrying it into effect. Human nature is only in certain phases influenced by a man's occupation, and whether resolutions are passed by "labourers" or by "professional gentlemen," they stand much the same chance of being forgotten after the press has recorded that they have been passed. Last year the Society of Arts in loyal response to the request of its Royal President, held a conference to discuss the water-supply question. After two days' work a resolution was carried urging that a small scientific commission should be appointed to collect information and suggest further inquiries on the subject. Twelve months elapsed and a few days ago another conference was held, when it was made known that the only step taken with regard to that resolution was that just before the Conference it had reached the Lords of the Treasury. Last year the Society directed that a *résumé* and sort of index should be made of what had been done by Parliamentary inquiries and official reports with regard to water-supplies, and the result was a volume called "Notes on Previous Inquiries," which, though very incomplete, may serve as a basis for a larger and more comprehensive work. The very fact of the imperfections in these notes showed to those more immediately connected with their compilation the need of enlisting wider sympathies if anything of real value was to be printed. A letter in the *Times* of April 14 of this year mentioned that although the notes had been published for many months, "not a single word" had been sent in response to the request printed on the back of the title-page that suggestions or corrections should be sent to the secretary. The idea was then suggested of founding a permanent free museum for the purpose of keeping before the public mind those subjects, apart from the question of low rates only, which should be considered in arranging water-supplies. It was decided that a temporary exhibition should be first tried as an experiment and after some difficulties in finding it a *locale*, the management of the Royal Aquarium kindly arranged for the use of the south gallery for the purpose. This exhibition is now open and a handbook is issued. It is marked "under revision," and on the title-page attention is appropriately drawn to the fact that it is the *first* public exhibition of the kind.

This handbook, we are told, has been drawn up under great disadvantages in many ways. One great difficulty has been that the exhibition has grown beyond what seemed at first likely to be its extent, and entries for the handbook have come from time to time, though but slowly. This was, perhaps, to be expected in an exhibition, the first of its kind, which was, therefore, to some extent, an experiment; and that many should hold aloof till success was assured was but natural. Although this gradual growth is a matter that must be a satisfaction to those interested in spreading a knowledge of what a study of water-supply means, it has entailed much unexpected labour on the part of the management.

Among those who have helped in the scientific sections are—Col. Beaumont, M.P., Col. Bolton, Baldwin Latham, F.R.S., J. G. Symons, F.R.S., J. E. Gardner, F.S.A., Dr. Granville Cole, Prof. Wanklyn, Prof. G. Bischoff, W. Cooper, Joseph Lucas, F.G.S., A. T. Atchison, M.A., C. E. De Rance, H.M.G.S., F.G.S., J. B. Jordan, F.G.S.

The comprehensive scope of the exhibition may be gathered from the following list of the sections into which it is divided :—

Section I.—Rainfall.
" II.—Geology and Hydrogeology.
" III.—Collection and Storage of Water.
" IV.—Suggested Development of Supplies.
" V.—Distribution of Water.
" VI.—Water Examination.
" VII.—Filtering.
" VIII.—Hardness.
" IX.—Disease.
" X.—Antiquarian.
" XI.—Pollution.
" XII.—Literature.
" XIII.—
Class 1.—Appliances for Cooling Water in Summer.
" 2.—Waters artificially Aërated.
" 3.—Miscellaneous.

A scientific committee has been formed to draw up a report on the exhibition, especially to point out what defects should be remedied in future exhibitions of the kind, and it is announced that next week "demonstrations" will be given on the sections embracing scientific apparatus.

NATURAL SCIENCE DEGREES AT OXFORD

MANY of our readers have no doubt noticed the scheme which some *soi-disant* "friends of science" in authority at Oxford have brought forward professedly in the interests of science. One of the prime movers in the new scheme for the creation of B.N.S. and M.N.S. degrees is Canon Liddon, who insists that for the degree of Arts Greek shall be indispensable, but for the inferior degrees in science may be dispensed with. Since the meeting of congregation at which the scheme was discussed, there has been much correspondence in the *Times* on the subject, the letters of most importance being those of Canon Liddon and Prof. Odling. The former in his correspondence professes to have the interests of natural science purely at heart in the creation of the new degree, which, he maintains, would give facilities to a much wider class to obtain the stamp of the University than if Greek were insisted on, as he maintains must be the case with *the* degree of the university. The opposition of Prof. Odling and those who think with him, is not to the creation of a degree in natural science, but to any course that would degrade it in public estimation. He urges on the university the desirability of framing such statutes in reference to any such degree, as shall assure it a high place in general estimation, and shall more especially obtain for it the approval and sympathy of the cultivators of natural science. He considers it important to this end that the possession of a degree in natural science shall imply on the part of the student, first, general cultivation, and second, special knowledge in some branch of science. But according to the proposed innovation, if

such general cultivation is based on classical studies, the student cannot get the new degree, but must take the Arts degree, which *quoad* natural science must be held to be an inferior degree. But he shows that by the proposed statute the science graduate need know little of natural science, as he may take his degree in the School of Mathematics; thus he shows a degree in natural science might be confined to those who had never got beyond its rudiments; why, then, he asks, does not Canon Liddon propose a new degree in mathematics, and thus "assign one set of students a new decoration which will honourably represent their real attainments." Prof. Odling shows that many of those who in the debate insisted on Greek being necessary to a degree in Arts, admitted it was not necessary to a liberal education; and thus, a degree in Arts must be held as something different from a certificate of liberal education.

"If, then, it be once conceded, and the concession was made without hesitation, that Greek is not essential to a liberal education, and that the studies of mathematics and natural science and modern languages do constitute liberal studies, how is it possible," Prof. Odling asks, "to refuse a degree in Arts to those who, in addition to considerable acquaintance with Latin and German, are possessed of special attainments in either mathematics or natural science, and also of not inconsiderable attainments in the alternative one of these two subjects."

According to the proposed statutes, Prof. Odling concludes, the new natural science degree, while it will certify to an ignorance of Greek, will not certify to a knowledge of natural science.

In reply to Prof. Odling, Canon Liddon asserts that Greek "is an instrument of unrivalled delicacy for effecting the general training of the mental powers, and especially for imparting to them those habits of exactness and refinement without which it is impossible to reach the higher characteristics of an educated man." "An education which excludes Greek," he maintains, "is certainly less liberal than an education which insists on it." For the liberal education of the highest order, only, according to Canon Liddon, to be attained by learning Greek, the highest honour of the University should be reserved; to a lower degree of liberality attained through means of natural science, even with a training in Latin or German, an inferior honour can only be conceded.

At present we give these arguments and assertions without comment.

NOTES

An influential committee has been recently formed for the purpose of obtaining subscriptions to procure a portrait of Dr. W. B. Carpenter, F.R.S., to be presented to the University of London as a permanent memorial of his long and assiduous labours on behalf of that institution. We need not say one word to commend the object of the "Carpenter Memorial Committee" to the practical consideration of our readers; Dr. Carpenter's services to science and to the London University are so well known, that we are confident the proposal of the Committee will meet with a satisfactory response. Earl Granville is chairman of the Committee, which contains many names eminent in science, as well as in other departments. The honorary treasurers are Sir John Lubbock and Dr. William Smith, to either of whom cheques and post-office orders should be made payable. Subscriptions should be sent to either of the honorary secretaries, J. G. Fitch, 5, Lancaster Terrace, Regent's Park, or G. Knight Watson, Society of Antiquaries, Burlington House.

We take the following from the *Gardeners' Chronicle*:—"The *London Gazette* of the 24th inst. announces that Her Majesty has been graciously pleased to confer the appointment of Companion of the Most Distinguished Order of St. Michael and St. George on George Bentham, Esq. While we rejoice to find some official recognition made of the life-long services to botany rendered by Mr. Bentham, we regret that such recognition has been so tardy, and that it is so inadequate. Such distinctions are not as a rule highly prized by scientific men, inasmuch as they are not specially appropriate to them; but if paid at all, they should be prompt and adequate." Baron von Müller, Government Botanist of Victoria, has been promoted to the dignity of Knight Commander of the same order, and a well-deserved knighthood has been bestowed on Mr. Henry Bessemer.

We regret to record the death at Halifax, Nova Scotia, of Prof. John James Mackenzie, at the age of thirty-two. After graduating from Dalhousie University, and passing several years as a teacher of mathematics and physics, he went in 1873 to Germany, where he underwent a thorough course of physical training at Leipzig. Here he received, in 1876, the doctor's degree, presenting an able dissertation on the absorption of gases by saline solutions, based on a most exhaustive and extensive series of experiments. The following year was passed in research in Helmholtz's laboratory at Berlin, where Dr. Mackenzie, among other results, succeeded in showing that in the relations hitherto supposed to exist between light and electricity, the optical phenomena observed were not due to electric tension itself, but probably in a secondary manner to the heat evolved. In 1877 he accepted a call to the Chair of Physics at Dalhousie University, Nova Scotia. At the commencement of a scientific career from which much was expected by his numerous friends, he was suddenly taken away by an insidious complaint induced a year since by the inhalation of the nitrous fumes from a Bunsen battery.

M. Gyldén has been elected a Corresponding Member in the Astronomical Section of the Paris Academy in place of the late Father Secchi.

We notice the appearance in May of the German *Jahresberichte über die Fortschritte der Chemie* for 1877. The present volume forms the thirtieth of the series founded by Liebig and Kopp, and is at present under the editorial supervision of Prof. Fittica of Marburg, assisted by a corps of eleven German and Austrian chemists. It is by far the most important and the most extensive of all annual reviews, and affords to even a superficial observer an interesting glimpse into the variety and extent of the chemical discovery of our day. Of its 1,400 pages, 196 are devoted to theoretical and physical chemistry, 120 to inorganic chemistry, 714 to organic chemistry, 66 to analytical chemistry, 152 to technical chemistry, 104 to mineralogy, and 46 to chemical geology. Of the space devoted to organic chemistry—more than one-half of the work—364 pages are occupied with the chemistry of the aromatic series, 48 with animal chemistry, 47 with vegetable chemistry, &c. The index of anthors contains over 1,750 names, and in comparison with the indices for 1867 (850 authors) and 1857 (720 authors) shows the rapid increase of late years in the number of those devoted to chemical research. Nine volumes of the *Jahresbericht* are now out of print, and complete sets are quoted at 800 marks. Individual volumes bring as high as 100 marks. German booksellers state that this rarity is occasioned in a notable degree by recent extensive purchases for public and private libraries in the United States.

During the past week Etna has been in active and increasing eruption. A very considerable number of new craters have opened, and that on both flanks of the mountain. The lava has reached many miles from the mountain, almost to the River Alcantara, laying waste the surrounding country. The village of Mojo has been destroyed, and others are threatened.

A volcanic eruption which has broken out in a mountain on the banks of Lake Balaton in Hungary, seems to have begun almost simultaneously with that of Etna, referred to in next note.

THE following are the most recent reports of earthquakes from various quarters:—From April 25 until May 2 repeated violent shocks were felt in the Senio valley in the Romagna. Several buildings were destroyed completely and many others damaged. The village of Palazzuolo suffered most, and the inhabitants left the dwellings and camped out in the fields.—Another series of shocks occurred at Shabka, in the Soroki district, Bessarabia; they were preceded by a subterranean noise similar to the report of a cannon, followed by a long rumbling noise. Twenty-four houses fell in; fissures appeared in the soil, from which water flowed out. Fifty-four trees were uprooted.—A third and fourth phenomenon of this nature were observed at Serajewo (Bosnia) on May 14 in the morning, and at Maramaros-Szigeth (Hungary) on May 18 at midnight. Altogether the volcanic phenomena in the Austrian Empire have been remarkable recently, and the signs of eruption shown by the Csobancz, one of the mountain cones on the shores of Lake Balaton, which has been extinct for centuries are no less so.—The last report which has reached us comes from Batavia, where, on April 4, a violent earthquake was observed. At Tjandjoer, some fifty miles from Batavia, a number of stone houses fell, burying many of the inhabitants beneath their ruins.—A Samarang paper states that the volcanoes in Eastern and Western Java are simultaneously in eruption. From the Smeru volcano a broad fiery stream of lava is making its way through a ravine to the sea-shore on the south, while at the other end of Java the Gedeh mountain is casting out an immense quantity of ashes, which spread themselves for miles round the neighbourhood.

AN exceptionally large meteor was observed at Herford (Westphalia) on April 25 at 8.30 P.M. The nucleus was nearly of the apparent size of the moon's disk, and its light was so brilliant that while the phenomenon lasted (*i.e.*, three seconds) no fixed stars could be seen.

THE Italian State Secretary for Public Buildings has sanctioned the plans submitted to him for the construction of an observatory on the summit of Mount Etna.

THE Anthropological Exhibition at Moscow seems to be one of great interest. It is contained in a vast building lent by the Minister of War, and used in winter for drilling soldiers, and the exhibition has been rendered as picturesque as it is scientific. A garden which has been arranged most artistically for the purpose presents, among other features, a very remarkable "palæontological valley." This is planted with lycopods, gigantic ferns, and other fossil plants; this forest is inhabited by models representing megatheriums, mammoths, ichthyosaurs, &c. On miniature mountains, the age of which is indicated by artificial geological sections, are shown *fac-similes* of Russian, French, Danish, and other tumuli. Besides this, an ethnological garden is peopled with models representing the principal human types, especially those of Russia. There is, besides, a remarkable anatomical and craniological exhibition. Altogether this is one of the most remarkable anthropological exhibitions ever brought together, and has been an immense success.

THE question of the definite location of the observatory for which a legacy of 700,000 dollars was provided by the late James Lick, has resolved itself into a selection of one of the three peaks of Mount Hamilton—Observatory Peak, 4,302 feet high; East Peak, 4,448 feet; and Middle Peak, 4,318 feet. At the suggestion, it is said, of Prof. Simon Newcomb, of the U.S. Naval Observatory, to whom the question was submitted, the trustees have referred the subject of a selection to Mr. S. W. Burnham, an amateur astronomer of some distinction. So soon as this decision is announced, the work of erection will be at once proceeded with.

A FEW weeks ago the fossil head of a *Rhinocerus tichorhinus* was found in Siberia, and is said to be in a very good state of preservation. The valuable object was presented to the Museum of Moscow University by the Siberian branch of the Russian Geographical Society, and will find a place in the Anthropological Exhibition at Moscow.

A NEW sensation is in store for visitors to Niagara; whether desirable or otherwise will depend on the tastes of the visitors. The "Niagara Falls Prospect Park Company" have ordered one of the largest-sized Brush machines and sixteen lamps, wherewith, by means of parabolic reflectors and otherwise, to throw light upon the descending water and upon the mist, "thus producing electric rainbows to order in the darkest night." It is also expected that a light can be placed behind the American fall, so as to throw rays out through the water.

THE death is announced of Karl Koch, formerly Professor of Botany in Berlin University.

WE hear that the Abbé Moigno, the editor of *Les Mondes*, who has just published a work in three volumes called "Les Splendeurs de la Foi," has disposed of his journal, and will proceed to Rome in order to lay before his Holiness the *comble* of his science. He may eventually be rewarded by being made a cardinal.

A VENERABLE relic of past engineering skill has been presented by the Earl of Lonsdale to the Patent Office Museum, South Kensington, where it may be seen by the public. This is a specimen of Heslop's Winding and Pumping Engine, a patent for which, numbered 1,760, was taken out in the year 1790. Heslop's engine, one of the immediate predecessors of James Watts's invention, was considered in the days of our great grandfathers to be an almost perfect machine, being superior to the atmospheric engine of Newcomen, even as improved by Smeaton. The present engine has been at work in the neighbourhood of Whitehaven for seventy-three years, having been erected at Kell's Pit for raising coal about 1795, afterwards removed to Castlerigg Pit, and thence to Wreath Pit in 1837. At the latter place it not only lifted coal out of the mine but worked a pump till last summer, when it was brought to London. The engine now at South Kensington is the last survivor of its race.

A TELEGRAM from New York, June 1, states that the States of Kansas and Nebraska have been visited by a tornado, by which about forty persons were killed and over one hundred wounded, while fifty buildings were destroyed, and the crops and other property greatly damaged.

MR. W. H. COFFIN writes us with reference to our note last week on the *conversazione* of the Institution of Civil Engineers. He states that the electric lamp for surgical use exhibited by him is an improved modification of M. Trouvé's "Polyscope Electrique," devised and constructed by Messrs. Coxeter and Son, the surgical instrument makers.

THE Municipal Council of Paris has resolved to adopt the cremation system on sanitary grounds.

AMONG various applications proposed by M. Planté for his secondary couples is that of electrical drilling. It is known that those high-tension currents (which he produces), when made to act on glass in presence of a saline solution, act like a graver or diamond, tracing grooves and making considerable hollows. Rock crystal may be thus attacked, spite of its hardness, and if it is not regularly engraved, it at least breaks into small fragments, and is ultimately disaggregated. Now, in America, black diamonds are used to attack hard rocks and effect the borings for mines. Might not these (M. Planté asks) be advantageously replaced by action of

the electric current in the way indicated? (The diamonds are very expensive and are gradually lost by being detached from the pieces to which they are fixed.) Platina electrodes would not be necessary, for it is not here the metal of the electrode that is altered, but the silicious matter, in presence of the saline solution. Metallic points or rods distributed suitably at the end of the drill-stem, insulated in part of their length and animated by rotatory motion, would bring the electric current to the surface of the rock to be pulverised. The progress recently realised in the production of electricity by mechanical means might facilitate this application.

IF perpetual motion be defined as that of a body which, after having received an impulse, continues to move indefinitely in virtue of its inertia alone, it is, M. Plateau considers, realisable. He introduces a foreign force of constant nature to destroy resistance, instead of (as in the case of a pendulum) restoring motion which resistance has withdrawn. Thus, conceive a horizontal disk movable round a vertical axis fixed to the centre of its under surface. A small hemispherical cavity is made on the upper face. A motor force of rapid rotation is got from a reservoir below the lowest water of a river, giving a uniform intense flow by a lower orifice. Before letting the water act on the disk, a top, previously set in very quick rotation, is deposited with its point in the middle of the hemispherical cavity; then the top is covered with a glass bell jar, which is fixed with its axis coinciding with that of the apparatus. The disk with the bell jar is then set rotating by means of the water in the same direction as the top. After a certain time (it may be supposed) the movements of disk, top, and inclosed air will be equalised; then the top will no longer experience resistance at its point, for the support turns as quickly as it and in the same direction; nor will it, from surrounding air, for this also has the same angular velocity. Thus we should have the curious spectacle of a top remaining indefinitely in equilibrium on its point, presenting a case of perpetual motion in the sense defined. Of course the water would have to be let off after action on the apparatus, also the surplus water of the reservoir.

WE have received from Messrs. Dent and Co. an interesting summary of the principal works executed by that house since its foundation in 1814. The last noted is the commencement in 1879 of the great galvanic chronographic apparatus of the Imperial Observatory of Japan.

TWO other volumes of the "Natural History Rambles" series have been sent us by the S.P.C.K.—"Mountain and Moor," by Dr. J. E. Taylor; and "Lakes and Rivers," by Mr. Groom Napier.

THE Asiatic Society of Japan are showing considerable activity in the issue of their publications, for another number of their *Transactions* has lately come to hand. This opens with some curious notes on the analysis of bamboo-shoots, which are much used as an article of food in Japan. Dr. Dwars arrives at the conclusion that the shoots examined at that period of their development must be considered a nourishing vegetable, and that they may even rival the cauliflower and asparagus. Mr. Satow supplies the first of a series of papers on ancient Japanese rituals, as well as some instructive notes on the vicissitudes of the Church at Yamaguchi from A.D. 1550 to 1586.

A NOTABLE change has taken place in the Jardin des Plantes of Paris, and should be noticed by foreigners. All the galleries and houses are open every day from one to four without any ticket of admittance being required from visitors. The plant-houses only are closed on Sunday.

A MUNICIPAL SCHOOL has been recently established in Paris for apprenticeship in the work of wood and iron.

A PART of the buildings of the Universal Exhibition has been purchased by the French War Office for the use of the aëronautical school at Meudon. It will be utilised for building and inflating balloons.

THE large Giffard Captive Balloon is ready for inflation, and the gas will be passed into it as soon as the state of the weather will permit the operation to begin.

THE additions to the Zoological Society's Gardens during the past week include a White-thighed Colobus (*Colobus bicolor*) from West Africa, presented by Dr. H. Hart; two Silky Marmosets (*Midas rosalia*) from South-East Brazil, presented by Mrs. Hector; a Capybara (*Hydrochœrus capybara*) from South America, presented by Mr. H. B. Whitmarsh; a Puff Adder (*Vipera arietans*) from West Africa, presented by Surgeon F. Speer; a Brown Hyæna (*Hyæna brunnea*) from South Africa, an Argus Pheasant (*Argus giganteus*) from Malacca, purchased; a Michie's Tufted Deer (*Elaphodus cephalophus*) from China, deposited; an Axis Deer (*Cervus axis*), born in the Gardens.

PREHISTORIC INVESTIGATIONS IN AUSTRIA[1]

I. *Lower Austria.*—At Mount Calvary, near Pellichsdorf, on the Marchfeld, a plain east of Vienna, explorations conducted by F. Heger, from June 26th, to July 28th, 1878. A great number of urns, pateræ, &c., of peculiar forms, not known from any other locality. Although broken by pressure, thirteen were more or less susceptible of reconstruction. Most of them were found in a space inclosed with strong beams of wood. A broken bronze armlet was also met with.

II. *Carniola.*—Explorations conducted by von Hochstetter and Ch. Deschmann, Superintendent of the Provincial Museum of Laibach.

1. Terszisce, near Zirknitz, July 16th, 1878, Prehistoric Fortified Station, and burial-ground, with human bones, more or less burnt, and many objects of bronze and iron, like those of the Celtic burial-ground of Hallstadt in Upper Austria.

2. Grad, near St. Michael, not far from Adelsberg, July 23rd, 1878. Separate skeletons, bronze objects, and Pre-Roman coins.

3. Slemschek, near Waatsch and Littai. Prehistoric Station of the "Hallstadt Period," with extensive burial-place. The graves are flat: some contain skeletons; others burnt remains. The latter are covered with heavy stone slabs, and contain large urns, of various forms, which have burnt bones within or underneath. Many objects, both ordinary and ornamental, of bronze, iron, amber, glass, bone, &c., were found, including a bronze helmet in excellent preservation. From July to October, 1878, about 200 graves were examined, mostly at the cost of the Provincial Museum of Carniola.

4. Dolle, near Gora and Waatsch. Separate graves, of the same character as those at Slemschek.

5. Vier, between Sittich and St. Veit, Lower Carniola. Above the village is a perfect ring-shaped earth-work; below it, on both sides of the high road a number of tumuli. Nearer St. Veit are flat graves, covered with slabs. This was probably the place of the *Acervone* of the Pentigerian Tables, or the Roman *ad Acervos*, which name, according to Prof. Müllner, is derived from these Pre-Roman tumuli.

6. Moratzch, near Heiligenkreuz. Flat graves and tumuli, August 1st, two skeletons were dug out, a male and a female, with earthen vases, iron knives, and a bone comb. These burials are probably later than those of Nos. 1-5.

7. Mariathal, south-east of Littai. Ancient castle surrounded with a rampart; also flat graves and tumuli containing skeletons August 2nd and 3rd, a male skeleton without arms, and with violently fractured skull was exhumed, together with many objects, including an elegantly ornamented urn, similar to those found at Slemschek.

8. Ober-Strascha, on the left bank of the river Gurk, above Rudolfsworth. Old ring-rampart and a few scattered tumuli.

[1] "Prehistorical Investigations in Lower Austria, Carniola, and Bohemia." By F. von Hochstetter, President of the Prehistorical Commission of the Imperial Academy, Vienna. (Imperial Academy of Sciences, Vienna, Meeting, January 16, 1879.)

9. Gradische, near Tepliz, Lower Carniola. Ancient castle with rampart.

10. Gsindeldorf, near Weisskirchen. Numerous tumuli, and traces of ancient dwelling-places; and some few bronze objects.

11. Landstrass, on the River Gurk. Many tumuli.

Besides the above localities of prehistoric dwelling and burial places, six others are known, but not yet explored.

12. Kreuzberg Cave, near Laas. This is very extensive, difficult to get at, and abounding with bones. In four days more than 2,000 bones of *Ursus spelæus*, besides more or less perfect skulls of the Bear, were taken out, belonging to at least from 40 to 50 individuals and possibly to a hundred and more. Most of the bones were scattered, but some remained together, so that a perfect skeleton was obtained for the Imperial Mineralogical Museum. Besides bones and teeth of the cave-bear, remains of *Gulo spelæus* and of a Marten (near *Mustela foina*), also cervical vertebræ of *Lupus*, and coprolites of *Hyæna* were found in this cave.

13. Jellenza Cave, near Tepliz, Lower Carniola. Excavations, August 5th, 1878, showed that this cave had been in-inhabited by Man.

III. *Bohemia.*—Of late years many antiquities have been met with about Hradischte, near Beraun, probably dating from the Marcomans and their predecessors the Boyans, who lived here apparently for centuries. Their burial-places, the tumuli near Lisek, and the old cemetery near Althütten, with its urns, have to be further explored. T. R. J.

SCIENTIFIC SERIALS

American Journal of Science and Arts, May.—Some experiments in cross-breeding plants of the same variety are here described by Prof. Beal, having been suggested by Darwin's book. The plants were Indian corn and black wax beans.—Prof. Young records observations of the spectrum of Brorsen's comet made on April 1 and 2. He is quite positive that the middle band of the spectrum now coincides sensibly (to a one-prism spectroscope) with the green band of the hydrocarbon spectrum.—Dr. Southworth demonstrates this theorem: If a hydrated salt be dissolved in a given volume of water, the volume of the solution will exceed the original volume of the water by a bulk equal to the bulk of saline water contained in the salt dissolved.—The first portion of a paper by Prof. Norton, on the force of effective molecular action, appears in this number, and the remaining papers deal mostly with geological subjects of more local interest, the Fox Hills Group of Colorado, the Hudson River age of the Taconic schists, the Wappinger Valley limestone of Dutchess County, N.Y., the Huronian series of Northern Wisconsin, the mineral locality in Fairfield County, Connecticut, &c.—Mr. Peters gives observations on the planet he discovered on March 21.

Annalen der Physik und Chemie, No. 4.—Herr Kayser here arrives at the conclusion that the velocity of propagation of sound-waves is independent of the intensity of the tone. His final method (two others, with use of Kundt's dust-figures, having been rejected) was to note the phases of vibration of a piece of mica at the top of a vertical glass tube used for resonance to a tuning-fork above it, set vibrating with different intensities by electric means. Water could be admitted laterally at the bottom of the tube, so as to obtain the maximum resonance. As the water-stopper is displaced, the same figure of vibration always returns whenever the displacement has reached half a wave-length. Herr Kayser finds the velocity of sound in free space 332·5m., calculated by Kirchhoff's formula from velocity in tubes, and making therein $\gamma = 0·0235$. (The case of explosion-waves is excluded from consideration, these being quite distinct in kind from sound-waves.)—Herr Wiedemann, in extension of a former research, takes up a number of points relating to torsion; repeated torsion in the same, or in opposite direction, permanent torsion of a wire often twisted a certain amount, influence of weighting during permanent and during temporary torsion, influence of oft-repeated weighting, rotation of molecules, action of vibrations, &c.—Herr Auerbach, considering (from the physiological, psychological, physical, and musical stand-points) what is the absolute number of vibrations required for production of a tone, thinks it is probably about *twenty*.—Herr Schmidt furnishes a new table of gas densities.—Herr Zöppritz continues his papers on hydrodynamic problems in relation to the theory of ocean currents.—Herr Sohncke replies to an objection by M. de Lapparent to his new theory of crystalline structure.—We have elsewhere referred to Herr Elster's researches on the electromotive forces which occur in free water jets.

Atti della R. Academia dei Lincei, March.—We note here the following:—On the secular variation of the magnetic needle at London since the year 1580, by Mr. Jenkins.—Researches on Cinchonine, by Prof. Fileti.—On the atmospheric disturbance of February 24 and 25 last, by S. Respighi.—On prenite and laumonite from the mines of Montecatini, by Prof. Bechi.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti. Vol. xii. fasc. vi.—We note here the following:—Influence of manures on the combustibility of tobacco, by S. Cantoni.—Considerations on the palatine bones, by Prof. Verga.—Some studies with reference to physiology and the expression of attention in man, by Dr. Riccardi.

Fasc. vii.—Rigid suspension bridges, by S. Clericetti.—On the area described by an invariable line moving in a plane according to a determinate law, by Prof. Bardelli.—On arithmetical hemiteria, by Prof. Maggi.—Some reflections on a recent note of Jamin, on the theory of dew, by Prof. Cantoni.—Reflections on the theory of dissimulated electricity, by S. Serpieri.—A steel yard densimeter, by Dr. Chistoni.

SOCIETIES AND ACADEMIES

London

Royal Society, May 8.—"On the Results of the Magnetical Observations made by the Officers of the Arctic Expedition 1875-76," by Staff-Commander E. W. Creak.

1. After leaving Portsmouth the first magnetical observations were made at Godhavn, Disko. On arrival at winter quarters, observatories were constructed where observations of the three magnetic elements and hourly observations of the differential declination magnetometers were made during the winter.

2. The diurnal variation or inequality of the declination formed one of the chief objects of interest at the winter quarters, as, although the period was remarkable for frequent magnetic disturbances, and an absence of brilliant auroras, no connection could be observed between appearances of that phenomenon and the movements of the declinometer magnet. This accords with the remarks of previous observers within the region comprehended between the meridians of 60° and 90° W., and north of the parallel of 73° N.

3. It has been established that 8 A.M. and 1 to 2 P.M. are the hours of the greatest easterly and westerly deflection of the declinometer magnet in middle latitudes. At the winter quarters, Discovery Bay, the westerly extreme was reached at 10 A.M., the easterly at 11 P.M.

4. An analysis of the disturbances of the declinometer magnet showed that the disturbing force never ceased, that it was at a minimum about the solstice, and a maximum at the equinox, and was greater during the day than the night.

5. Comparing the days of principal disturbance at Kew and at the winter quarters' observatories, it was found that for the most part the disturbances occurred on the same days. The two greatest disturbances or "magnetic storms" occurred on February 19 and March 25-26, 1876, during the same hours of Greenwich mean time as at Kew, but the magnets were often in opposite directions from the normal at the two stations.

6. An important result obtained was the evidence of but small secular change having occurred in the inclination and force since the observations of Kane and Hayes in 1854 and 1861 respectively. The declination is, however, more decidedly changing, especially about Godhavn, the needle moving towards the east as in England.

May 15.—"Note on a Recent Communication by Messrs. Liveing and Dewar," by J. Norman Lockyer, F.R.S.

In my paper of last December[1] I called attention to the importance of discussing Young's observations of the chromospheric lines in connection with the spectra of the metallic elements. In subsequent communications I have given preliminary results of this discussion so far as it has already proceeded.

Since my paper was read Messrs. Liveing and Dewar have, in a paper printed in the last number of the *Proceedings*, given a table which professes to state the number of times various lines in certain metals were seen by Young in connection with certain reversal phenomena observed by themselves.

[1] *Proceedings*, No. 191, p. 172.

The statements, however, made in this table with regard to the visibility of certain lines in the chromosphere do not appear to be in accordance with Young's published tables, and as Messrs. Liveing and Dewar have in a still later paper drawn theoretical conclusions from these statements, I think it desirable to call attention to the fact, in order to prevent any confusion which might otherwise arise.

It will be sufficient to refer to two cases.

I. Messrs. Liveing and Dewar state that two lines of aluminium, the wave-lengths of which they give as 6245 and 6237, have each been seen by Young eight times.

According to Thalén's measurements, which are the best that we possess, there are no lines of aluminium in these positions. He gives, however, lines at 6244·0 and 6234·0.

Young, moreover, states that he saw reversed a strong line (clearly shown in Ångström's map to be an iron line) at 6245·4, and a line which he does not ascribe to any element at 6237·3, which is more than three divisions of the scale from the position of the aluminium line.

II. In the case of potassium, Messrs. Liveing and Dewar give two lines at wave-lengths 4044 and 4042 as having been seen by Young three times. I know of no potassium lines at the places given; Young, moreover, has recorded the reversal of no potassium line in this region. What Young distinctly states he saw, was the reversal of the iron line at 4045·0, which is one of the most marked iron lines in the spectrum of the sun. To this reversal I referred in my paper of December 12.[1]

It is perfectly true that there are two potassium lines in this region: they were not mapped by Thalén, and they were only seen as a single line by Lecoq de Boisbaudran[2] and the wave-length, given as 4045, as his dispersion was limited, did not enable us to determine its true position with reference to the Fraunhofer lines.

Last year, however, I not only stated the double nature of this line on photographic evidence,[3] and pointed out that both components were absent from the spectre normal, but I gave their wave-lengths as 4042·75 and 4046·28 (positions which will only find the last place of decimals altered, even if it be altered, in the revision of the map now being proceeded with), and on the strength of them announced the existence of potassium in the sun. Messrs. Liveing and Dewar do not state whence their wave-lengths were derived, neither do they refer to my communication.

It would appear therefore not only that the reference to Young's work in many cases is founded upon some misunderstanding, but that a higher degree of accuracy than that employed by Messrs. Liveing and Dewar is necessary to determine such coincidences.

I may state generally that my eleven years' work on this special branch has led me to the conclusion that all statements of coincidences between metallic and solar lines with a lower degree of accuracy than that employed by Thalén and Young are to be avoided when possible, as they may be worse than useless, they may mislead. Indeed, though the map on which I am working is on twelve times the scale of Ångström's, it would be better if it were larger; and when I say this I must add my tribute of admiration of the accuracy of the work of those who have preceded me, notably Ångström, Thalén, Cornu, and Young, with whose work I am more familiar, as it is expressed in wave-lengths.

May 29.—"Note on the Spectrum of Sodium," by J. Norman Lockyer, F.R.S.

I have lately been engaged in studying the spectrum of sodium under new experimental conditions. In anticipation of a detailed communication I take leave to state that the vapour given off from the metal after slow distillation in a vacuum for some time shows the red and green lines without any trace whatever of the yellow one. Hydrogen is given off in large quantities, and at times the C line and the red "structure" are seen alone. After this treatment the metal, even when red-hot, volatilises with great difficulty.

Linnean Society, May 1.—Lieut.-Col. Grant, C.B., vice-president, in the chair.—Mr. Edw. S. Morris exhibited a quantity of the berries, whole and ground, of the *Coffea liberica*, grown by him near Monrovia.—A living example of the rare and curious *Welwitschia mirabilis*, reared at Kew, was shown and commented on by Mr. W. T. Thiselton Dyer.—The chairman also called attention to a series of the teaching diagrams illustrating the "Anatomisch-physiologischer Atlas der Botanik," now being issued by Dr. Arnold and Carolina Dodel-Port, of Zurich.—A paper on nutrition in its relations to the fertilisation of flowers, by Mr. Thos. Meehan (Philadelphia, U.S.), was read. His observations chiefly refer to *Wistaria sinensis*, *W. frutescens*, *Catalpa syringæfolia*, and *Limina perenne*, from which he deduces that the struggle for power between the growth or vegetative and the reproductive forces decides fertility. He further suggests that the perfection of the polleniferous organs, and consequent potency of pollen, is dependent on phases of nutrition involved in this struggle. Thus in the above-mentioned plants it is seen that potency in pollen—the main element in the reproductive force—operates only when there has been some check given to the force of vegetative growth.—The Rev. G. Henslow read some remarks on Mr. Meehan's contribution, these in the main supporting his views. He states, with regard to the different facts and interpretation of experiments, that results however accurate and true for one country may be very different for another, as has been shown to be the case with *Escholtzia*. We cannot, therefore, be too cautious in presuming that because a phenomenon may invariably occur in our experience it must necessarily do so everywhere and at all times. He recognises five degrees in the effects of the reproductive force—1. Entire abeyance when no flowers are produced. 2. Flowers abundant, but pollen remains a mass of tissue, as in *Ranunculus ficaria*. 3. Flowers produced with good pollen, but no seed set as in *Escholtzia*. 4. Fruit produced only at definite places, as extremity of raceme, or at definite periods, as late in summer. 5. Flowers and fruit occur in abundance as in "tree" *Wistaria*, or freely growing branches of ivy.—A paper on the structure of the Pouched Rats, of the genus *Heteromys*, by Dr. J. Murie, was read in abstract. The anatomical structure and other peculiarities have been worked out and a comparison with other forms given, along with remarks on the sub-family Heteromyinæ generally.—The Secretary read a note by Dr. M. Masters, on the occurrence of a Restiaceous plant in Cochin China, an interesting fact in the geographical distribution of the group.—Messrs. T. E. Brown (of Adelaide), Richd. Rimmer, and P. O. Shanessy (of Queensland), were elected Fellows of the Society, and two Foreign Members were chosen to fill vacancies.

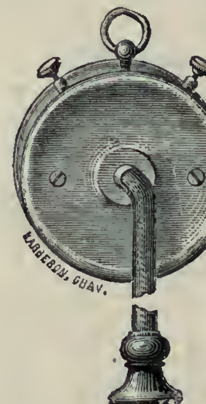
Geological Society, May 14.—Prof. P. M. Duncan, F.R.S., vice-president, in the chair.—The following communications were read:—Further observations on the pre-Cambrian rocks of Caernarvon, by Prof. T. M'Kenny Hughes, F.G.S. The author divides these into (1) the volcanic series, (2) the felsitic series, (3) the granitoid series. He traces the former of these, consisting of coarser and finer varieties, from Caernarvon to near Port Dinorwig. Beyond these come the felsite series, which is overlapped by grits and conglomerates as far as the Bangor Road, north-east of Bri hdir. Above the latter comes the "volcanic series," well developed in the neighbourhood of Bangor. The author is of opinion that the Cambrian conglomerate, with associated grits, may be traced in the edge of the older massif from Twt Hill, Caernarvon, to Garth Point, Bangor, and that the beds in each of these places and near Brithdir, recently described as separate, are identical; also that the bed with purple fragments near Tairffynnon and the Bangor Poorhouse are only Cambrian conglomerate faulted down. Further, he considers that the strata of the above three series are fairly parallel throughout, and that they only form three subdivisions of one great series.—Notes on the structure of the palæozoic districts of West Somerset, by A. Champernowne, F.G.S., and W. A. E. Ussher, F.G.S. The authors confirmed the general accuracy of Mr. Etheridge's views as to the structure of North Devon and West Somerset, but differed from him in ascribing the limestone of Cannington Park to the carboniferous, both on account of lithological character, the fossils in Taunton Museum, said to be obtained from it, and the latitude of its position with reference to the carboniferous limestone of the Mendip, South Wales, and the steep and flat Holmes. They described four traverses made by them in West Somerset. 1. From Dulverton to Dunster, in which, proceeding northwards, the following beds were encountered:—Culm-measures faulted against Pilton Beds (upper Devonian), Pilton Beds faulted against Pickwell-Down sandstone (base of upper Devonian), Pickwell-Down sandstones becoming slaty in passing into Morte slates (middle Devonian) and troughed in them by faulted synclines, Morte slates passing into Ilfracombe slates (overlying Hangman grits) near Cutcombe, Hangman grits, evidently

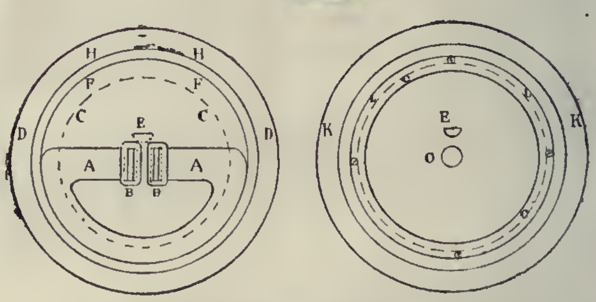
[1] *Proceedings*, 191, p. 172.
[2] "Spectres Lumineux," texte, p. 48.
[3] *Proceedings*, No. 186, p. 280.

faulted against Foreland grits, as no representative of the Lynton beds is present between Oaktrow and Timberscombe. In traverse 2 the fault between the Hangman and Foreland grits is proved by the presence of the Lynton beds in the valley west of Luccot Hill and their conformable infraposition to the Hangman series, and abrupt termination by fault against the Foreland grits of Porlock and Oare Hills. At Oare a patch of schist of the Lynton zone was noticed resting on the Foreland grits on the north side of the fault. The 3rd traverse in the Tone Valley gave the following succession of beds:—Culm-measures on Pilton beds; Pilton beds with grits, much flexured, on Olive slates with *Lingula* and grits with *Cucullæa*, conformably overlying Pickwell-Down grits, which make a conformable junction (following the feature) with the underlying quartziferous slates of the Morte series (middle Devonian); the latter were observed between Huish Champflower and Clatworthy; but, as the middle Devonian slates appear to extend considerably northward in the Brendons, they were not traversed beyond Clatworthy. The 4th traverse from West Quantockshead to Cannington Park proved the composition of the Quantocks along that line to be grits, in places associated with schistose shales, apparently belonging to the Hangman series (middle Devonian); whilst the palæozoic inliers, in the triassic area of Bridgewater, are unlike the Quantock rocks in character. The limestones of Asholt and Hollwell, associated with slates of the Ilfracombe series, are very similar to varieties of the South Devon limestone, and are quite unlike the limestone of Cannington Park.—The Whin Sill of Teesdale as an assimilator of the surrounding beds, by C. T. Clough, F.G.S. Owing to the general absence of mechanical disturbance, the author is of opinion that "the Whin consists in part of altered sedimentary beds, that it partly represents beds which were once in the position it now occupies, that it did not make room for itself simply by thrusting aside these beds, but also by incorporating them into itself." He proceeds to describe sections at Caldron Snout, Cronkley Fell, Noon Hill, &c., which seem to him inexplicable on any other theory. The author discusses objections on chemical grounds, holding that the general uniformity in chemical composition of the Whin may be explained by supposing the absorbed beds to have permeated a large mass of the Whin, as an alloy does melted metal. He thinks the explanation may be extended to other intrusive masses.—On the silurian rocks of the valley of the Clwyd, by Prof. T. M'Kenny Hughes, F.G.S. The author gives a preliminary sketch of the silurian rocks of the southern and western part of the Clwyd Valley. He describes first some beds below the horizon of the Denbigh grits at Ffriddfawr which agree very well in their characters with the base of the Coniston grit, and others near agreeing with the passage-beds between these grits and flags. He next describes sandstones in the Clywedog Valley, the equivalents of the lower grits; and lastly, at Bod Renail, flags, &c., the Pale States, which contain graptolites, and are thus to be identified with the graptolitic mudstones of the Lake-district. Thus he is of opinion there is a basement-series here for the Silurian, corresponding in all its details with that in the Lake-district.

Zoological Society, May 20.—Prof. W. H. Flower, F.R.S., president, in the chair.—Mr. Sclater called the attention of the meeting to several animals and other objects of interest observed by him during a recent visit to some of the zoological gardens on the Continent.—Prof. Owen, C.B., read a paper in which he gave the description of a portion of the mandible of a large extinct kangaroo, proposed to be called *Palorchestes crassus*, from the ancient fluviatile drift of Queensland.—A communication was read from Mr. M. Jacoby, containing descriptions of new species of coleoptera of the family *Halticidæ*.—Mr. Sclater read a paper (the fourth of the series) on birds collected by the Rev. George Brown, C.M.Z.S., on Duke of York Island, and on the neighbouring parts of New Britain and New Ireland. The present collection contained fifty-nine specimens belonging to forty-two species, of which several were believed to be new to science.—A communication was read from Prof. Garrod, F.R.S., containing a series of notes on the anatomy of the Gelada baboon (*Gelada rueppelli*), based on the examination of a specimen that had died in the Society's Gardens. Prof. Garrod came to the conclusion that *Gelada* must be considered as a distinct generic form, more nearly allied to *Cercopithecus* than to *Cynocephalus*.—Lieut.-Col. Godwin-Austen read some notes on and gave a description of the female of *Ceriornis blythi*, Jerdon.

Physical Society, May 10.—Prof. W. G. Adams in the chair.—New Member, Mr. J. Kestrell Evans.—Mr. Wollaston explained the construction of Gower's improved form of Bell's speaking-telephone. The older form, made of wood or ebonite, is open to the objections that it has a very weak voice, soon gets out of adjustment from changes of temperature, and requires a twisted hand-wire which is liable to break. Gower's form has a comparatively loud utterance, is constant, and does not require to be held in the hand, but may be laid on a table or hung on a wall, a speaking-tube leading from it to the operator's ear or mouth. The "call" for attracting attention is also within the Gower telephone itself, whereas in the hand telephone it is an auxiliary apparatus. Every organ of the old telephone has been modified to form the Gower. The magnet A A in the figure in the Gower is of a horse-shoe form, very powerful, the two poles being brought very close together, and each pole is mounted with a small coil of fine wire, B B; the diaphragm C C is much thicker and longer than the Bell diaphragm, the case, D D, is of brass, to expand equably, and a speaking-tube is fitted to the front of the diaphragm. F F is the interior and K K the exterior circumference of the box. The call, E,





consists of a musical reed attached to the diaphragm so as to be opposite a small slit in the latter. To sound the call it is only necessary to send a sharp puff of wind up the speaking-tube, and the reed gives out a note which is heard throughout a room at the distant end. Speaking and cornet music was transmitted by the instrument exhibited, between the third storey over the hall and the meeting. It was very distinct and audible several feet from the receiver. Speaking done some thirty feet from the transmitter was also sent. Conversation was likewise carried on while considerable noise was being made in the room. Prof. Macleod remarked that the timbre of this telephone was very good. —Prof. Barrett then gave an account of some attempts which he had made to overcome the induction clamour on telephones caused by the ordinary telegraph currents on neighbouring wires. He had tried recently the Bell telephone on a line from Dublin to Armagh, ninety-five miles long, but the induction noises completely stifled the speaking, whereas the Edison transmitter gave good results. The clamour could be got rid of either by neutralising the induction currents, or by eliminating the noises from the speech. He had taken the second line of experiment. Since the vocal currents differ from the induction ones in potential and period, he attempted to make the latter discharge across from the line to earth by fine needle points, and from a heated spiral of wire, in a vacuum, leaving the vocal currents to

pass on to the receiver, but without success. Also since the vocal currents are alternately positive and negative, whereas the induction ones are of one sign, he tried to avail himself of the difference in discharging power of positive and negative currents, but without success. He then tried to take advantage of the difference of period or duration of the currents, the induction currents being longer. He therefore tried to break up the induction-currents by interposing a rapidly revolving current interrupter, and to make the sections of the musical note obtained *interfere* with each other by means of an acoustic interference-tube, but practically failed in this also. He mentioned these facts for the benefit of others who may be going over the same ground. Mr. Wollaston pointed out that a perfect cure for induction on underground wires consisted in twisting the going and returning wire of the telephone circuit round each other.—Mr. Wilson then read a paper on the divisibility of the electric light by incandescence. By Joule's law the amount of heat developed in a circuit of resistance, R, by the passage of a current $C = C^2 R$; where R is the resistance of generator and connections, r, added to the resistance of the light emitter or incandescent wire, P. Therefore since by Ohm's law $C = \frac{E}{R}$ we have—

$$C^2 = \frac{E^2}{(r + P)^2}, \text{ and } C^2 P = \frac{E^2 P}{(r + P)^2}.$$

From this equation the value of P may also be determined. $C^2 P$ is the amount of heat developed in the incandescent wire. He infers that the smaller the mass of the wire the higher the temperature generated in it, therefore the mass of the wire should be diminished until the fusing point of the metal is almost attained. The question of divisibility resolves itself into our being able to divide a single incandescent source into a number of smaller ones giving the same total illumination. The author concludes that this can be done by arranging the subdivided sources in "multiple arc" or parallel circuits, provided the total mass, length, and sectional area of the united sources be the same as in the original single source. The objection that increased radiation from the various sources would diminish the first total of light and heat can be met by making the smaller wires still smaller than is theoretically required so as to generate more heat. The author regards the "voltaic arc" as probably falling under the same law, the mass, however, being smaller in this case.—Dr. Coffin then exhibited a Trouvé polyscope, which consists of a small, hand, incandescent platinum wire electric light, designed for illuminating the more inaccessible cavities of the body in surgical examinations. The current is supplied by a Planté secondary battery, and the light is half inclosed in a small silver reflector fitted with a convenient handle. The apparatus is portable. Dr. Coffin found that it was open to several objections which he has remedied. Firstly, the heat generated made the lamp so hot that it could not be held to the body for more than a very short time. He overcame this by making the reflector of double silver plates, and circulating water between by means of india-rubber pipes and a bulb which can be worked by the patient himself, thus serving to distract his attention from the operation. Secondly, the secondary battery exhausts itself in twenty minutes, and the light therefore goes out, while from twelve to twenty-four hours are required to recharge it. Dr. Coffin has superseded it by a Leclanche battery of eight elements, made by Messrs. Coxetter and Sons, in which the carbon pole is replaced by a copper plate faced with platinum, and no porous diaphragm is employed. This gives a constant light for hours.

Anthropological Institute, May 13.—Prof. W. H. Flower, LL.D., F.R.S., vice-president, in the chair.—Mr. Hyde Clarke read a paper on the ethnology, mythology, and philology of races of early culture: Babylonians, Etruscans, Egyptians, Japanese, &c. Pursuing his former investigations, he now produced the comparative philology of Akkad, Coptic, Etruscan, Lydian, Phrygian, Thracian, Carian, &c., copiously illustrated. He showed the relationships of these among each other and with the Ugro-Altaic languages, Georgian, the Himalayan, Naga, Kolarian, and other Indian languages; Basque, the Pomo, Hidatsa, and other American languages. All these he further showed to be related to the numerous languages now spoken in the more advanced highlands of Central and Western Africa, as Mandingo, Bornu, Pulo, Timbuktu, Houssa, Ashantee, &c. By reference to these larger stocks he conciliated the divergences which appeared on the intercomparison of other languages. Thus he illustrated many disputed points in the Akkad grammar of M. Lenormant, and the alleged relations with the Finnic. In treating the murology of the subject Mr. Clarke referred to the marked differences between the Koord, Persian, Armenian, and Eastern Aryans, and the Germanic and other Western Aryans. His conclusion was that the so-called Eastern Aryans are descendants of the pro-existing Turanians, having merely acquired an Aryan language, and are to be assimilated to the Georgian and other white Turanians, to the Assyrians, and the Semites. To them he assigned the Etruscans and Lydians. If the Aryans were to be regarded as descended from High Asia, then the white Turanians may have descended from High Africa, and they were the authors of the early culture. When their power fell, although in Europe and Western Asia they were replaced by the Aryan migrations, yet in other regions they were extirpated by the black and brown (or red) natives. Abyssinia, in conformity with its own legends, was to be regarded as one of the last centres of this ancient empire, and the Himyarite as one of the last invasions under Semitic leaders. To the earlier epochs he assigned the American migrations and the mound-builders, when he considered the Pomo as the possible language. Tracing a like conformity in a primitive mythology as in philology, the author marked out a Turanian epoch of Greece and of Rome, and explained the relation between Etruscan and Norse mythology by the existence of a Turanian epoch of culture among the Germanic nations.—Mr. A. L. Lewis communicated a paper entitled "Notes on some Irish Antiquities." He observed that the country round Dublin, while considered by Irish antiquaries to be comparatively destitute of rude stone monuments, nevertheless contained as many as some of those districts in England where they were most plentiful. In the island of Howth, to the north of Dublin Bay, are the remains of a dolmen called Finns Quoit, the cap-stone of which measured no less than 15 feet long by 6 feet in thickness. South of Dublin, in the ground of Mount Venus, seven or eight miles from the city, is a stone 20 feet long by 3 feet thick, leaning against one 8 feet high. At Killiney Station, on the road to Bray, are remains known as the Druids Altar and Druids Chair. The finest dolmen is in Carrick mines where five upright stones support a capstone 17 feet long by 14½ inside, and nearly 5 feet thick, forming a chamber 10 feet square. In construction these remains resembled those known as the Trevethas Stone in Cornwall. Of tumuli in Ireland the largest sepulchre is probably that known in the New Grange tumulus situated between Navan and Drogheda. Its peculiarities were noticed by the author and contrasted with the remains at Gavr Inis, in Brittany, and with the cuneiform chambers at Wayland Smith, at Wellon, near Bath. Remains that have been observed in the burial-ground of the Abbey Church of Slane, near Navan, were next described, and the paper concluded with some interesting observations on the well-known round towers of Ireland, and with novel suggestions as to their origin and purpose.

Royal Microscopical Society, May 14.—Dr. Beale, F.R.S., president, in the chair.—This was the first meeting in the Society's new room.—Papers were read by Mr. A. W. Waters, F.G.S., on the occurrence of recent Heteropora; by Mr. J. Davis, on a new species of Cothurnia; and by Mr. Wenham, on homogeneous immersion objectives.—The exhibits included photographs of blood-corpuscles, by Dr. Treadwell; Rutley's petrological microscope, by Mr. T. W. Watson; and various microtomes, by Mr. Crisp, &c.—Five new Fellows were elected, and eight nominations read for the next meeting.—The second scientific evening of the session, held on May 21, was very numerously attended, many objects of novelty and interest being exhibited, together with apparatus, amongst which were oil-immersion objectives, by Zeiss and Powell and Lealand.

Photographic Society, May 13.—J. Glaisher, F.R.S., in the chair.—Mr. C. Bennett read a paper in reply to the discussion on a previous paper read by him, on gelatine emulsions. He stated that he still held the opinion that when an emulsion was lightly salted with silver bromide, the particles were fine, and remained so during long emulsification—as also the converse with heavily salted specimens. With respect to the light admitted for working his extremely sensitive emulsion, he found that four square feet of four thicknesses of deep ruby glass were preferable to one square foot of one thickness.—Mr. T. S. Davis, F.C.S., read a paper on preparing small quantities of gelatine emulsion, advocating the admixture of the silver and bromide salts in powder to the gelatine solution instead of previously dissolving them.—Mr. W. S. Bird read a paper on

the photography of vision, showing from researches made by M. Kuhne and Prof. Boll, that a visual purple pigment existed in the eye, and a theory therefrom of a result similar to that in photography, viz., a fixation of an image by physical changes in certain minute rods and cones found in some membranes of the retina, the experiments recorded tending to the old theory that the eye of a deceased person or animal retained the last visual impression.

Statistical Society, May 20.—Mr. Wm. Newmarch, F.R.S., vice-president, in the chair.—The paper read was by Mr. John B. Martin, M.A., banker, of Lombard Street, "On some Effects of a Crisis on the Banking Interest."

EDINBURGH

Royal Society, June 2.—Sir C. Wyville Thomson, vice-president, in the chair.—The following communications were read:—On the carboniferous volcanic rocks of the basin of the Firth of Forth: their structure in the field and under the microscope. Second paper, by Prof. Geikie.—Additional observations on the fungus disease affecting salmon, by A. B. Stirling, Conservator of the Anatomical Museum (communicated by Prof. Turner).—On the form and structure of the teeth of *Mesöplodon layardi* and *M. sowerbyi*, by Prof. Turner.

PARIS

Academy of Sciences, May 26.—M. Daubrée in the chair.—The following papers were read:—On the refraction of obscure heat, by M. Desains. With a view to getting lenses which will cause to converge to a point rays from the beginning and end of the dark spectrum, he tries to follow and recognise in dark spectra a given group of rays, spite of differences in the refringent and dispersive powers of the bodies employed, so as to reach the absolute value of the refractions of dark rays of given length in different diathermanous bodies. Hence may be calculated the radii of lenses of flint and crown glass, *e.g.*, which will give the convergence sought.—Chemical researches on the formation of coal, by M. Fremy. He concludes that coal is not an organised substance; it has taken plant impressions readily, because of its bituminous and plastic nature. The plants which produced coal seem to have first undergone *peaty fermentation*, which destroyed all vegetable organisation, and the coal was formed at expense of the peat, by a secondary action, produced by heat and pressure.—Determination of the difference of longitude between Paris and Berlin, by MM. Lœwy and Le Clerc. Astronomers of the two countries made simultaneous observations in contiguous tents, but with instruments and methods of their own choice. The principal differences of method are indicated. From the French observations (in one series of which M. Lœwy was in Berlin and M. Le Clerc in Paris, in the other *vice versâ*), the ultimate value of the difference of longitude with Cassini's meridian was 44m. 13·99s. (careful tests were applied). This showed a difference of 0·13s. with the German's result, which the authors think due to a slight variation of the optic axis in one or other of the instruments of either mission. From the various longitudes effected in Europe, several values of the longitude between Paris and Berlin may be deduced indirectly, and the authors hope, by discussing these numbers, to arrive at the true value.—On the distribution of work to a distance by electrical means, by M. Tresca. This relates to experiments made at some sugar works. A Gramme machine driven by a steam-engine, set in action another Gramme machine 400 metres or 650 m. off (as desired), and this latter rotated a drum with cable, which worked a double plough. An effective force of 3 horse-power was thus transmitted. The (copper) wire was formed of nine strands 1 mm. diameter, giving a section of 7 square mm. The first Gramme rotated 1,123 times per minute, the second 890.—On earthquakes which occurred in the East from the seventh to the seventeenth century, by M. Tholozan. According to the data obtained, Persia seems to have been most frequently attacked (the other countries are Mesopotamia, Egypt, Syria, Arabia, and Magreb); but one cannot draw very exact conclusions from the records. M. Tholozan, however, is able to contradict von Hoff's assertion that from the beginning of the thirteenth to the second half of the seventeenth century there was almost complete cessation of earthquakes in Syria and Judea; and Quatremare's, that the north-east of Africa has been almost always exempt.—M. Gyldén was elected Correspondent in Astronomy in room of the late P. Secchi.—On the characteristics of functions, by M. Jordan.—On a new representation of imaginary quantities, by M. Dupont.—New demonstration of the law of reciprocity, in the theory of quadratic residues, by M. Schering.—On the development of cot. x, by M. Le Page.—On the fluorescence of salts of earthy metals, by M. Soret. The liquid was placed in a quartz vessel, on which was concentrated, with a quartz lens, the light of the induction-spark passing, *e.g.*, between cadmium electrodes.—On the determination of calorific wave-lengths, by M. Mouton. The method was that of M. Fizeau, freed from the uncertainty resulting from ignorance of the law of dispersion of double refraction of the plate employed in calorific radiations.—On a peculiar mode of transmission of sound to a distance, by M. Decharme. One may, by a purely mechanical process, transmit 5, 10 . . . metres, the different sounds of a vibrating plate, a tuning-fork, or a stringed instrument, by putting these in communication, by means of metallic wires not stretched but in spiral, with suspended sheets of Dutc metal or tin (the fastenings are with wax).—On the diffusion of lithia and its presence in sea-water, by M. Marchand. He claims to have found lithia in sea-water before M. Bunsen did.—On the salts of guanidine, by M. Jousselin.—Experimental researches on the physiological signification of the terminal nervous plexus of the cornea, by M. Ranvier. The arrangement seems simply relative to the transparence of the cornea. The nerves themselves are nerves of general sensibility.—On the metamorphosis of cantharides (*Lytta vesicatoria*, Fab.), by M. Lichtenstein.—On the body-cavity of sedentary annelids, and their segmentary organs; some remarks on the genus Phascolosoma, by M. Cosmovici.—On the *Taenia giardi*, and on some species of the group of Inermes, by M. Moniez.

VIENNA

Imperial Academy of Sciences, March 20.—The following among other papers were read:—On *Cerianthus membranaceus*, a contribution to the anatomy of the Actinia, by Dr. von Heider.—Action of salt solutions on aldehydes (continued), by Prof. Lieben and Herr Zeisel.—On the formation of a rational plane curve of the third order on a conic section, by Prof. Weyr.—On the passage of light-rays in a homogeneous ball, by Prof. Lippich.—On the chemical composition of pyroxilin and the formula of cellulose, by Prof. Eder.—On the relation between heat-radiation and temperature, by Prof. Stefan.—Studies on ellagic acid, by Prof. Barth and Dr. Goldschmiedt.

April 3.—On the methods of investigating the polar actions of the electric current in striated muscle, by Prof. Hering.—On the polar actions of the electric current in muscles deprived of nerves, by Dr. Biedermann.—On phosphate of zinc, by Herr Demel.—On the solution of dynamical problems by means of Hamilton's partial differential equation, by Dr. Hocevar.—Contribution to a knowledge of copper chloride, by Herr Rosenfeld.—Geological description of North-east Thessaly, by Herr Teller.—On some points in geography and geology of European Turkey, by Dr. Boué.—Researches on the diffusion of salt solutions, by Herr Schulemeister.—On resorcindisulpho-acid, by Herr Tedeschi.—Action of melting caustic soda on aromatic acids, by Herren Barth and Schreder.—On derivatives of a phenoldisulpho-acid, by Herren Barth and Schmidt.—On a local influence on the magnetic observations in Vienna in the period 1860-71.

CONTENTS

THURSDAY, JUNE 12, 1879

EVOLUTION, OLD AND NEW

Evolution, Old and New; or, The Theories of Buffon, Dr. Erasmus Darwin, and Lamarck, as compared with that of Mr. Charles Darwin. By Samuel Butler. (Op. 4.) (London: Hardwicke and Bogue, 1879.)

THE present work will not add to the reputation of the author of "Life and Habit." It is, nevertheless, an interesting and useful book, inasmuch as it gives a pretty full account of the theories and opinions of several authors whose writings are almost unknown to the present generation of naturalists. The sketch of the lives, and the numerous quotations from the works of the celebrated men named in the title page, are instructive and sometimes amusing. Quotations are also given from Mr. Patrick Matthew, Étienne and Isidore Geoffroy St. Hilaire, and Herbert Spencer, illustrating their views on evolution, and giving altogether a fair idea of the progress of modern thought on this important subject. But the main object of the book is to show that all these authors have been right, while Mr. Charles Darwin is altogether wrong; and that the works of the former contain a more philosophical, more accurate, and altogether superior view of the nature and causes of evolution in the organic world than those of the latter.

Mr. Butler finds in all the writers whose views he advocates, opinions which agree more or less closely with those so ingeniously and forcibly developed by himself, and to which full justice has already been done in the pages of NATURE (vol. xix. p. 479). No one can object to his adducing these points of agreement to fortify his own position, or to his arguing that his own hypotheses, thus supported, form an important and even a necessary supplement to the theory advocated by Mr. Darwin. But he goes much further than this, and maintains that the action of external conditions, combined with the desires and habits of animals, are the all-powerful causes of evolution, and that "natural selection," or "survival of the fittest," is comparatively unimportant, and is quite unworthy of the position given to it by Mr. Darwin and his followers. In doing this he not only falls into much confusion as to the phenomena of variation, but indulges in an amount of petty verbal criticism, quite unworthy of the high reputation established by his previous work; and I believe that naturalists in general will endorse the remark in my review of "Life and Habit" (which Mr. Butler has, apparently under the impression that this volume refutes it, placed in a conspicuous position on the fly-leaf of his book), that "the want of a practical acquaintance with natural history leads the author to take an erroneous view of the bearing of his own theories on those of Mr. Darwin."

In discussing the views and arguments of Buffon, Mr. Butler suggests that the numerous contradictory statements of this eminent writer are due to the necessity he was under of not arousing the enmity of the Church. He therefore adopts the method of directly contradicting himself whenever he has been a little too advanced. Over and over again he points out the evidence of the several families of animals and plants having each had a common ancestor, and he specially mentions the horse and the ass, man and apes, as having been thus derived. But he puts it all hypothetically, and then, to satisfy the Sorbonne and the public, he proceeds thus: "But no! It is certain from revelation that all animals have alike been favoured with the grace of an act of direct creation, and that the first pair of every species issued full formed from the hands of the Creator." These, and numerous other passages quoted, certainly support the theory that many of Buffon's statements are ironical; and that while himself a firm believer in the development of all organisms from common ancestors, he purposely contradicted himself sufficiently to prevent the suppression of his work as being opposed to religion.

Most interesting among the quotations from Buffon, however, are those which show how near he was to seizing upon the idea of "selection" as a means of modifying organisms. Thus he says:—"The dog is short-lived; he breeds often and freely; he is perpetually under the eye of man; hence when—by some chance common enough with nature—a variation or special feature has made its appearance, man has tried to perpetuate it by uniting together the individuals in which it has appeared, as people do now who wish to form new breeds of dogs and other animals." And again, in discussing the origin of our cultivated fruits, &c., he says: "It was only by sowing, tending, and bringing to maturity an almost infinite number of plants of the same kind that he was able to recognise some individuals with fruits sweeter and better than others." Here he clearly recognises the selection of individual variations as the source of varieties, and the necessity for breeding or growing on a large scale, in order to obtain such individual variations as are required. But he never laid hold of this idea with any firmness; for we find him elsewhere dwelling on the influence of change of climate, food, and treatment, as having produced the changes in domestic animals and cultivated plants; especially change of climate while accompanying man in his migrations, and the action of these changes on habits "influencing their natures, instincts, and most inward qualities."

We next come to Dr. Erasmus Darwin, of whose life, writings, and opinions a very interesting account is given, and who is an especial favourite of Mr. Butler on account of his views as to the transmission of memory and habit from parent to offspring, and as to the existence of sensation and voluntary motion in plants, although he laid more stress on imitation and instruction than on inherited habits, and in this departs widely from Mr. Butler. Dr. Darwin anticipated Lamarck in arguing that the transformations of animals "are in part produced by their own exertions in consequence of their desires and aversions, of their pleasures and their pains, or of irritation or of associations; and many of these acquired forms or propensities are transmitted to their posterity." He also had a glimpse of the mode of action of sexual selection; for, speaking of the spurs with which the males of many game birds are armed, and which they use in fighting, he says: "The final cause of this contest among the males seems to be that the strongest and most active animal should propagate the species, which should thence become improved." We cannot see, however, that he had any clear notion of the general action of the law of the

survival of the fittest, nor of the important part it necessarily plays in the accumulation and perpetuation of variations, however these may be caused. In this respect he was probably not so enlightened as Buffon.

Lamarck's writings are very largely quoted and his opinions fully illustrated; and we freely admit with Mr. Butler that, as a thorough and consistent evolutionist, he was not inferior to Mr. Darwin himself. But although he clearly saw the *fact* of evolution, and almost demonstrated the reality of the fact by a variety of arguments and a wealth of observation, yet, so far from adducing any adequate *causes* for evolution, he was actually inferior to his predecessors Buffon and Dr. Erasmus Darwin, since he appears to have had no glimpse of the way in which domestic races have actually been produced by human selection, and still less of the action of the law of the survival of the fittest on animals and plants in a state of nature. Everything he imputes to changed conditions and changed habits, developing new desires in animals and inducing new courses of action. He dwells much on the time required for these changes, and considers that we have a practically unlimited amount at our disposal, remarking that "a time infinitely great *qua* man is still infinitely short *qua* nature."

Lamarck is exceedingly vague in his statements as to the cause and mode of change. After describing the different kinds of locomotion, walking, leaping, flying, swimming, and the great need of these powers of movement to most animals, he adds: "Since, then, the power of locomotion was a matter affecting their individual self-preservation, as well as that of their race, the existence of the want led to the means of its being gratified." He does not seem to have perceived the struggle between individuals of the same species owing to their excessive numbers, but only the struggle between distinct races; as when he says: "The strongest and best armed for attack eat the weaker, and the greater kinds the smaller. Individuals of the same race rarely eat one another; they war only with other races than their own." He also refers to the excessive multiplication of the smaller kinds of animals, and shows how their numbers are limited, but he never observed that the race was thereby invigorated and might even be modified. He sums up his theory in the following three propositions:—

"1. That every considerable and sustained change in the surroundings of any animal involves a real change in its needs.

"2. That such change of needs involves the necessity of changed action in order to satisfy these needs, and, in consequence, of new habits.

"3. It follows that such and such parts, formerly less used, are now more frequently employed, and in consequence become more highly developed; new parts also become insensibly evolved in the creature by its own efforts from within."

These arguments are repeated in a variety of ways, and are applied to explain the origin of all our breeds of dogs and other domestic animals, as well as of all wild species; and he evidently had no notion that though these may be real causes, they would be utterly inadequate to produce any such effects as we see in nature without the accumulating power of natural selection. Mr. Butler, indeed, maintains that this power is implied in Lamarck's reasoning. He maintains "that one [of the most important conditions of an animal's life is the relation in which it stands to the other inhabitants of the same neighbourhood—from which the survival of the fittest follows as a self-evident proposition." And he adds: "Lamarck would not have hesitated to admit that, if animals are modified in a direction which is favourable to them, they will have a better chance of surviving and transmitting their favourable modifications."

But it is clear that Lamarck neither saw it nor admitted it; and his theory is therefore radically deficient. And he evidently sees this deficiency himself, for he says that frequent crosses with unmodified individuals will destroy the effect produced, and that therefore isolation is necessary.

We come next to Mr. Patrick Matthew, who in 1831 put forth his views on the development theory in a work on arboriculture; and we think that most naturalists will be amazed at the range and accuracy of his system, and will give him the highest credit as the first to see the important principles of human and "natural selection," conformity to conditions, and reversion to ancestral types; and also the unity of life, the varying degrees of individuality, and the continuity of ideas or habits forming an abiding memory, thus combining all the best essential features of the theories put forth by Lamarck, Darwin, and Mr. Butler himself. The following quotations illustrate Mr. Matthews's views:—"As the field of existence is limited and preoccupied, it is only the hardier, more robust, better-suited-to-circumstance individuals who are able to struggle forward to maturity, these inhabiting only the situations to which they have superior adaptation and greater power of occupancy than any other kind; the weaker and less circumstance-suited being prematurely destroyed. This principle is in constant action; it regulates the colour, the figure, the capacities, and instincts; those individuals in each species whose colour and covering are best suited to concealment or protection from enemies, or defence from inclemencies or vicissitudes of climate, whose figure is best accommodated to health, strength, defence, and support; in such immense waste of primary and youthful life those only come forward to maturity from the strict ordeal by which nature tests their adaptation to her standard of perfection and fitness to continue their kind by reproduction." He then goes on to show how this law tends to the production of almost uniform groups of individuals which we term species, and then adds: "This circumstance-adaptive law operating upon the slight but continued natural disposition to sport in the progeny, does not preclude the supposed influence which volition or sensation may have had over the configuration of the body." This, he says, is a matter to be inquired into, as well as "its dependency upon the preceding links of the particular chain of life, variety being often merely types or approximations of former parentage; thence the variation of the family as well as of the individual must be embraced by our experiments." These, and many other passages, show how fully and clearly Mr. Matthew apprehended the theory of natural selection, as well as the existence of more obscure laws of evolution, many years in advance of Mr. Darwin and myself, and in giving almost the whole of what Mr. Matthew has written on the subject Mr. Butler will have helped to call atten-

tion to one of the most original thinkers of the first half of the 19th century.

The last four chapters of the work are devoted to a critical comparison of the theories of Mr. Darwin with those of Lamarck, Dr. Darwin, and Buffon, greatly to the disadvantage (in Mr. Butler's opinion) of the former. Much of this criticism, however, is merely verbal, and is quite valueless; much of it, also, is founded on a confusion as to the meaning of such terms as "variation" and "variety," and on an inability to grasp the fact of the extent and universality of the individual variations of organisms; while another portion arises from taking the hypotheses of Lamarck as established facts. Of these several classes of unsound criticism we will give a few examples.

Mr. Butler first quotes (p. 339) numerous expressions from the "Origin of Species," referring to our great ignorance of the laws of variation, and our total ignorance of the cause of each individual difference; and then speaks of Lamarck "having established his principle that sense of need is the main direct cause of variation," and that variations thus engendered are inherited, which sufficiently accounts for all the facts. If Lamarck had "established" anything of the kind, Mr. Darwin and all evolutionists would certainly have followed him, but he nowhere proves or even attempts to prove his "principle," but merely states it as an "hypothesis" to account for facts which he saw no other way of explaining. Again, Mr. Butler himself says, that owing to the conditions of life being permanent for long periods—"The thoughts of the creature varying will thus have been turned mainly in one direction for long together; and hence the consequent modifications *will also be mainly in fixed and definite directions* for many successive generations; as in the direction of a warmer or cooler covering, &c. . . . It is easy to understand the accumulation of slight successive modifications *which thus make their appearance in given organs and in a set direction.*" The passages which I have italicised look like statements of fact—of what actually occurs; yet no such facts have ever been made known. If the law thus stated had been sufficiently effective to produce any permanent variations, breeders would sometimes have made use of it. Yet they certainly do not do so, whereas they do systematically and very successfully make use of selection. According to the above theory Australian sheep must have their thoughts constantly turned in the direction of less wool owing to the great heat of the climate, and a much larger proportion of each succeeding generation should have thin and scanty fleeces than occurs in England, especially in the tropical colony of Queensland, which, in proportion to its population, produces as much wool as the other colonies. If Mr. Butler could adduce, on good authority, such a fact as this, he would have some evidence in his favour, instead of which he can only make suppositions. The fantail and pouter pigeons, the crested Poland fowls, and all other strange domestic varieties, have been produced by selection of variations or sports which occurred among animals all subject to the same tolerably uniform conditions; while no proof has ever been given that anything more than very slight changes can be produced and perpetrated by change of conditions unaided by some kind of selection.

Mr. Butler's want of appreciation of what variation and natural selection really are, is shown by his referring to "the fact that *one* in a brood or litter, is born fitter for the conditions of existence than its brothers and sisters"—by his continually laying stress upon Mr. Darwin not having shown "how the individual differences first occur"—by his thinking that because natural selection is not the cause of "variation" it is therefore not the cause of "modification" or of a "variety" or "species"—and by his hardly ever referring to the enormous multiplying powers of animals, and the consequent extermination of a much greater number annually than the whole average living population. In my former article on the works of Mr. Murphy and Mr. Butler (NATURE, vol. xix. p. 477) I have shown how we may look at the whole population of a species at any given time as divisible, with regard to any one of its characters, into a more and a less developed moiety, and I believe that this mode of viewing the question will at once almost entirely remove the coincident-variation-in-the-right-direction difficulty, which forms the great stumbling-block of almost all the opponents of Mr. Darwin.

The difficulty as to the "cause of variation" also disappears from this point of view, for "variation" is seen to be synonymous with "want of perfect identity" between any two organisms, and this is clearly due to the almost infinite complexity of structure and minuteness of parts of all living things and the absolute impossibility that any two can have passed through an identical series of conditions or even had an origin in two identical germs. We see infinite variety arise in the inorganic world where there is a far less complexity of structure or variety of conditions. Even among the sands on the sea-shore no two grains are probably so nearly identical that a good microscopist could not detect a difference; while it is certain that nowhere in the world are there two hills or two rivers with any approach to complete similarity, though the entire process by which many of them have been produced must have often been almost identical. Variation, such as *always* occurs between the individuals of a species, is therefore an ultimate fact of nature which wants no further explanation than that we cannot even conceive it to be otherwise. We may indeed conceive more likeness on the average than actually exists, but we cannot really conceive of *perfect identity* between individuals formed and developed as are animals and plants. We may, on the other hand, seek for the causes of unusual or abnormal variation, and Mr. Darwin has suggested several. It is quite possible that those suggested by Lamarck and Mr. Butler may also be real causes, but they have certainly not been proved to be so; and even if they had they would not in the least affect the law of natural selection which *accumulates and perpetuates variations*, however they may have been produced.

The numerous verbal criticisms or quibbles in which Mr. Butler indulges are quite unworthy of his subject. When Mr. Darwin says, "Variation will cause the slight alterations," Mr. Butler remarks that this is the same as saying "Variation will cause the variations." Again, Mr. Butler maintains that the term "conditions of existence" is identical with or includes "survival of the fittest," which is identical with "natural selection." Therefore, when Mr. Darwin says "natural selection is

the main but not the exclusive means of modification," he must mean "the conditions of existence are the main," &c., &c.; therefore he really agrees with Lamarck, whose opinions he has called "erroneous!" Again, because Mr. Darwin has once used the term *nature*, metaphorically, for natural selection, our author seizes hold of it for a little ridicule, thus: "When, therefore, Mr. Darwin says that natural selection is the most important, but not the exclusive means whereby any modification has been effected, he is really saying that nature is the most important means of modification—which is only another way of telling us that variation causes variations, and is all very true as far as it goes." In the same style the use of the term "by *means* of natural selection" is criticised, and the use of "natural selection" at all, when "survival of the fittest" is admitted to be a more accurate term; and Mr. Butler seems to think that if the latter term were always used, a great deal of the force of Mr. Darwin's arguments would be lost. I venture to assert, however, that every argument can be stated with equal accuracy and effect, using only "survival of the fittest;" but there is this great advantage in using the term "natural selection," that it keeps before the mind the striking analogy and almost identity between the action of man and of nature in modifying species, an identity that was never seen by any of the older writers, but which was first clearly apprehended by Mr. Patrick Matthew, and first fully worked out by Mr. Darwin himself.

In the last chapter Mr. Butler takes the celebrated case of the Madeira wingless beetles to test the respective theories of Lamarck and Charles Darwin, and he could hardly have made a more unfortunate choice. According to Lamarck, he says, when a beetle found the wind taking it in a wrong direction, *which it knew would be fatal to it*, it ceased flying, and thus, by long-continued disuse, gradually lost its wings. Here we have the assumption that such insects as beetles know beforehand that if blown out to sea they will be drowned, an assumption for which not one particle of evidence is adduced, while, as every entomologist knows, pages might be filled with facts proving that insects of various orders do not possess any knowledge of the kind, but year after year go recklessly to their death by myriads.

Hardly less weak than this statement of the Lamarckian theory is the objection to that of Mr. Darwin, which is as follows:—"For Mr. Darwin cannot mean that the fact of some beetles being blown out to sea is the most important means whereby other beetles come to have smaller wings—that the Madeira beetles, in fact, come to have smaller wings, mainly because their large-winged uncles and aunts go away." Though Mr. Butler has tried to put this so as to look like an absurdity, it is strange that he cannot see that it contains an important truth. If the "large-winged" beetles go away, the small-winged remains to breed, and each succeeding generation will have, on the average, smaller wings than the last; and if, so long as any fly at all, the larger-winged continue to "go away," at last none will fly, and then, the wings being unused, will become abortive and rudimentary. As a crucial case, and to compare the power of the two theories as agents of change, let us suppose them both applied to the human inhabitants of Britain. First we will suppose all the men and women above the average height to go away year by year to Australia or elsewhere, while those under the average height remained. Does Mr. Butler doubt that at the end of, say, ten generations, the average height of English men and women would have been considerably reduced? This would be selection pure and simple. Now for the Lamarckian theory. Let all the people be taught (and believe) that to be short is to be beautiful and virtuous, and let all doors and all public vehicles be made low to suit short people and inconvenience tall ones, and moreover, let short people alone be eligible for a number of posts of honour and dignity, there would thus be created a general desire to be short oneself and to have short children, and the Lamarckian principle would be brought fairly into play. Now supposing that no artificial selection of any kind was practised, and that, owing to the prevalence of high moral principle, the health, lives, and affections of tall people were valued and cared for as much as those of their more favoured short fellow-countrymen, does Mr. Butler seriously maintain that at the end of ten generations any perceptible effect would be produced on the average height of the people; or that anything like the same amount of effect would be produced as by the other experiment? But if not, then "selection," whether natural or artificial, is the *main cause* or *means* of modification; the plain reason being that it accumulates differences which actually exist, whereas, by the other mode, you must produce an increase or diminution of these differences by causes which have not been proved to act at all, and which, even if they do produce any effect, can only do so with extreme slowness.

In conclusion, then, we may admit the possibility that the causes of variation adduced by Lamarck, as well as those so well set forth by Mr. Butler in his "Life and Habit," are real causes; we may further admit that some or all of these causes are essential to the origin and development of the more important organs of animals, and that they constitute the chief supplementary agencies the existence of which Mr. Darwin himself recognises; but, even admitting all this, we still maintain that they would be all powerless to effect great or permanent modifications without the accumulating action of natural selection, which may therefore be truly described as the "means" by which alone the "origin of species" has been actually brought about.

ALFRED R. WALLACE

OUR BOOK SHELF

Elementary Arithmetic and How to Teach It. By George Ricks, B.Sc. (London: Isbister, 1879.)

MOST school-books, especially those of an elementary character, are mere poison, and very disagreeable poison too. But Mr. Ricks has supplied us in this volume with really healthy food. We heartily recommend it to all young teachers, and believe, moreover, that many who deem themselves experienced may obtain from it several useful hints. In Part I. the teacher of an infant school is shown how to proceed with his pupils; in Parts II. and III. similar information is afforded to the teacher in a junior school; Parts IV. and V. relate to senior schools; Part VI. is devoted to advanced scholars. We have discovered nothing very remarkable in the latter half of the book; indeed, Mr. Ricks seems to get a little beyond himself as soon as he advances from the juniors to the seniors. This, however, is a matter of small consequence.

It is the elementary part of a subject which is always so badly taught, chiefly because it is a general belief that any one can teach a child. We are, therefore, pleased to welcome in Parts I., II. and III., an exceedingly clear statement as to what sections of arithmetic should be taught, and how they should be taught to young children.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

A Machine for Drawing Compound Harmonic Curves

IN NATURE (vol. xx. p. 103) there appears an abstract of a paper by Prof. E. W. Blake on a machine for drawing compound harmonic curves. Prof. Blake is doubtless not aware that this machine is based on a plan proposed by Prof. Perry and myself in our paper on "the music of colour and visible motion," read before the Physical Society, November 23, 1878. In that paper, after the description of our own motion-compounder, will be found the following :—"But it is possible that in our new machine we shall adopt a totally different plan, and one which we think is new. If the two extremities of a long rigid rod have parallel motions perpendicular to the rod, the middle of the rod has a motion equal to half the sum of the extremities. Thus the parallel motions of 2, 4, or 2^n points may be compounded. Similarly for 3 points, one-third of the sum of parallel motions is obtained from the centre of a rigid triangular piece of which the points are the corners; so that by bars and frames of simple construction it is easy to get the sum of the parallel motions of any number of pieces."

But I think that this method which we suggested, and which is the one now described by Prof. Blake, is inferior to the roller-cam principle employed by us in the instrument we constructed, and explained to the Physical Society, in that with the latter in its complete form we can alter, while the machine is actually in motion, the *amplitude* as well as the *phase*, by any *desired* amount, of *any one* of the component vibrations. This facility, although not possessed, as far as I am aware, by any other motion compounder, is extremely desirable for the varied description of compound curves, whether these curves be merely intended, as in the ordinary forms of such instruments, to show the resultant of two or more vibrations, or be designed, in accordance with the plan of Mr. Perry and myself, to work on the emotions, in the rendering of a new genus of music, by the varied, yet controlled, motions of the body, or bodies, describing these curves.

W. E. AYRTON

Lightning Conductors

ON the night of Wednesday, May 28, shortly after ten o'clock, my father's house at Caterham, in Surrey, was struck by lightning. We had not noticed any thunder before going to our bedrooms, but shortly after doing so we saw a very vivid flash, followed by thunder after an interval of perhaps five seconds; three or four minutes after this there came with a terrific crash the flash which struck the house, and afterwards no more thunder or lightning sufficient to attract our attention while we were intent upon investigating the mischief done.

The house stands high, upon a hill upwards of 700 feet above the sea; it is somewhat higher than any house or other object in its immediate vicinity. Roughly speaking, it may be described as a square block surmounted by a steep tiled roof, the ridge of which runs north and south, and astride upon the ridge stand two chimney stacks of equal height; from one corner of the square block runs away an extension, the roof and chimney stacks of which are upon a somewhat lower level.

Upon the northern chimney stack, at its eastern end, was the lightning conductor, which consisted of the usual hollow rod (½ inch) at the top, continuous with a flat plaited rope of copper and zinc wire (1 inch in width), carried through glass insulating rings along the slope of the roof, over the rain-water gutter, and down the side of the house into the ground.

The flash first struck the lightning conductor, hurled the rod down, and shattered the chimney-pots and a little of the brick-work; it seems to have followed the chimney-stack down to the ridge of the roof, and there to have divided. That portion of the discharge which passed down the eastern slope of the roof seems to have followed the chain portion of the lightning conductor as far as the rain-water gutter (iron); this it slightly broke, and broke also two panes of glass immediately beneath it, but this portion of the flash could be traced no further, and dead leaves, &c., about the remainder of the lightning conductor would seem to indicate that none had passed down that, at least not any large quantity.

The greater part of the discharge seems to have utterly left the guidance of the conductor, and to have first followed the lead flushing of the chimney stack down the western slope of the roof; a foot or so below the end of the flushing the roof was perforated, and the tiles broken and thrown down; thence, without any disturbance of the intervening tiling the discharge leapt a distance of some 15 feet, perforated horizontally a 9 inch-brick wall, covered on its exterior by weather tiling, and so reached an iron water cistern immediately within this wall. The woodwork about the cistern was started, but not much splintered; thence the discharge passed downwards by way of the water pipes, down two stories to a force-pump in the scullery, and thence, probably, by the pipes, down into the subterranean water-tanks.

But the pump in the scullery was provided with a pipe and tap over the sink, and there was also a small "tell-tale" pipe from the cistern above, designed to show when the cistern had been filled. This also terminated over the sink. Along these some part of the discharge was led, and not being safely conducted away, threw down and shattered the slate about the sink.

The perforation in the brick wall was circular, large enough to easily admit one's finger, and was blackened on its interior; when first found, eight or ten minutes after the occurrence, it was still quite hot.

The practical question that presses for an answer is, what did the lightning conductor do for us? Its selection as the point struck seems as though it brought the discharge upon the house; certainly it, although I believe of the usual construction, was utterly inadequate to carry off, or even direct the course of, the discharge, for a most copious and violently destructive discharge passed altogether from it and down over the opposite or western slope of the roof.

On the other hand, the iron water-tank and its pipe system proved adequate and safe conductors of the electric fluid, which left not the smallest trace of its passage along them until it reached the scullery sink, and there would presumably have done no harm, had it not been for the existence of the tap pipe, which led a portion of it astray. And on both faces of the house the iron gutters and rain-water pipes seem to have proved efficient conductors, for no violently destructive effects were manifested, save the breaking of two panes of glass after the electric fluid reached them. But as I am no electrician I can add nothing useful to the bare narration of the facts. I should add that the soot was very completely and violently ejected into the rooms from the chimneys of the stack struck.

CHARLES S. TOMES

P.S.—Subsequent closer examination of the portions of the lightning-conductor showed that there were traces of fusion of the hollow copper rod at its junction with the rope which had been inserted into it; the sectional area of copper here available for carrying the discharge seems to have been less than that in either the rod or the rope. Slighter traces of fusion existed here and there in the whole length of the rod. In its passage round the water-gutters the discharge cracked each one at its junction with the next segment; that is to say, the iron was cracked wherever the interposition of a little red lead to make the joint tight offered increased resistance to its passage, and the lead flushing of the roof was fused below the perforations in the brick wall, indicating that the whole discharge did not go through the wall to the iron water-tank.

THE effects produced by the recent thunderstorms are so interesting and instructive that I think it worth while to record the results of investigations which I have made personally or had made for me.

On May 31 there was published in the *Times* particulars of the damage done to the church at Laughton-en-le-Morthen, and the conductor was described as a thin corrugated tube of copper made

in sections, apparently fastened together, but in fact disconnected and with bad earth contact.

A disastrous result followed the use of a similar conductor in the case of Mr. Osbaldiston's house near Sheffield, in the storm of Tuesday, the 5th instant, when his house was completely wrecked.

Here the flash, after coming partly down the tube and breaking the worse than useless insulators, left the conductor about nine feet above the ground, and passed through a thick wall to the gas-pipe, behind the drawing-room mirror, which it smashed to atoms, broke some Sèvres vases on the mantelpiece, melted the gas-pipe and set fire to the gas, destroyed the gilded ceiling and cornice, ripped up the floor above, destroyed the furniture, and in short did damage estimated at about 500*l*.

In this case the lightning having left the conductor to go to the gas-pipe shows that the corrugated tube contained too little metal—though it was seven-eighths of an inch in outside diameter, and that the earth contact of the tube was not so good as the gas-pipe.

The next case which I have had examined was Mr. Tomes's house at Caterham, which was struck on Wednesday, May 28, about 10 o'clock P.M. The supposed conductor here was a woven band about an inch wide, made of twelve small copper wires, with two zinc wires interwoven! forming a worse conductor than the copper tube. The top terminal appears to be made of a soft alloy of tin and zinc, with a small steel wire in the centre! This was fastened on to a thin copper tube measuring half an inch outside and about six feet long.

To the lower end of the tube the band was attached, and here again the abominable glass insulators were used. The tube was fixed to a chimney and the band carried over the roof, coming in contact with the iron water spout on its way down. The end of the band was simply struck into the chalky soil to a depth of about a foot, so that it formed a very bad earth contact.

The lightning struck the point (the alloy round the steel has been melted or broken off some time ago, for the steel point is rusty), and passed down the band to the iron water-spout, which went round the eaves of the roof till it came to some lead flushing on the other side of the house away from the conductor; it then went up the lead, which it partially fused, and entered a small water-cistern in the attic, which luckily was connected by an iron pipe leading to a large iron tank under the ground, which thus formed an admirable earth contact. The distance to the conductor to the top water-cistern was about fifteen feet.

The damage done in this case was limited to little more than breaking two panes of glass and the glass insulators, and it proved that the band did not form an efficient conductor.

The third case which I have to report occurred on the same afternoon as that at Sheffield. The church of Saint Marie, Rugby, was struck, and might have been burned to the ground, had not the workmen employed in repairing the spire taken shelter in the church from the coming storm. They had been on the top and saw a dense black cloud approaching, and luckily came down, and had not been long in the church which, at 3 P.M. was so dark that they could scarcely see each other at a distance of a couple of yards, when a terrific crash was heard, and as suddenly the gas under the organ loft was lighted and the woodwork began to blaze. The men got the fire extinguished, and found that the lightning had melted the soft metal gas-pipes at a T-piece joint.

The spire is 212 feet high, and when it was built a conductor of copper-wire rope half an inch in diameter had been fixed. This has been repaired at the top by the present contractor attaching to it about fifty feet of rope of seven-eighths diameter. No insulators had been used, and so far as could be ascertained by a short inspection, the conductor appeared complete.

About half way up the spire there is a peal of eight bells. These have iron wires about one-eighth of an inch diameter leading from the clappers down to the back of the organ loft, but terminating in the spire a short distance from an iron gas-pipe about one inch in diameter fixed against the wall of the organ loft.

In this case I think that the rope conductor carried off part of the flash, and that part came down the bell-wires and went through the wall to the gas-pipe, for part of the stone wall next the organ, about a foot in diameter, was exploded off and thrown into the organ loft. The flash then partly ran along the iron pipe and melted the soft metal pipe, which is three-quarters of an inch diameter and a sixteenth thick, and set fire to the gas, and the remainder of the flash went to earth.

It was fortunate that no one was working the chimes, for if he had he would certainly have formed part of the circuit and been killed. The church, however, escaped with very slight damage.

R. S. NEWALL

Bud-Variation in Bananas

IN my garden there is a large plant (planted about eleven years ago) of a variety of banana, distinguished by purplish stems and petioles, red fruits, and by a very peculiar flavour of the latter. From the centre of this plant, covered by the rotten stems of former years, there are now growing green stems, with green petioles; one of them has already produced fruits, which were green when immature, and yellow when ripe, and the flavour of which I found to be but slightly altered. All the young stems growing from the circumference of the plant are purplish.

May not many of the varieties of bananas have been produced by bud-variation?

FRITZ MÜLLER

Itajahy, April 7

Fertilization of Erica carnea

ALL our Vaccinieæ and Ericaceæ, with tubular corolla, as far as hitherto known, are adapted to cross fertilization by Apidæ; for instance, *Vaccinium myrtillus* and *Vitis idæa*, *Arctostaphylos uva ursi* and *Erica tetralix*. I was, therefore, much struck yesterday by the observation that *Erica carnea* is abundantly visited and cross fertilized by a butterfly, *Vanessa cardui*, but not by a single bee. And, indeed, the colour and structure of this flower corresponds far more to the taste and habits of butterflies than of Apidæ. Like all other alpine flowers adapted to butterflies (*Saponaria ocymoides*, *Silene acaulis*, species of Dianthus, etc.), *Erica carnea* is also of a gay red (pink) colour, and its inclined tubular corolla is so narrowed downwards that its small opening is almost completely occupied by the anthers projecting from it. Hence butterflies which are most distinctly attracted by the colour of this flower, as also by its structure, are alone able easily to insert their thin proboscis into its corolla and to reach its honey.

Wherever in a sunny place of the Albula Valley *Erica carnea* is in full flower, and I observed more than thirty such places yesterday and to-day, *Vanessa cardui* is frequently found visiting and fertilizing it—so frequently that sometimes five or six specimens are visible at the same time.

HERMANN MÜLLER

Bergün, in the Albula Valley, June 3

Early Sun-Spot Records

To the very small number of non-Chinese observations of solar spots prior to the invention of the telescope we may add one, which I find in the voyages of Henry Hudson, published by the Hackluyt Society. He appears to have noticed such a phenomenon on March 21, 1609. Hudson says, "Then we observed the sunne, having a slake, and found our heigth to bee 70 deg. 30 min." A note says, the word slake, as a substantive, seems to be a north country word, meaning according to Brocket "an accumulation of mud or slime from slijck, cœnum, lutum." It will be remembered that there is a paper by Mr. Williams, the late Secretary of the R.A.S., on Chinese observations of solar spots in the monthly notices for April 1873. Mr. Williams's translation records forty-five such between the years A.D. 301 and 1205 inclusive. It will be seen that this list does not correspond with that given in Mr. Hosie's communication to NATURE of June 5. In the above interval Mr. Hosie records twenty-four spots not mentioned in Mr. Williams's paper; and in the latter there are nine recorded that do not occur in the longer list of Mr. Hosie. The number of naked eye records of sun-spots that may be brought to light will never be sufficient to carry back Dr. Wolf's sun-spot periods previous to the introduction of the telescope. There is, however, another Chinese record that it would be interesting to see translated. Mr. Williams, in the paper referred to, says, "these observations are continued in the supplement to Ma Twan Lin's Encyclopædia," and that he had found in the history of the Ming dynasty many observations of solar spots, the latest being November 29, 1638.

SAMUEL J. JOHNSON

Upton Helions Rectory, Crediton, June 9

A Meteor and the Weather in New Caledonia

According to my promise to send you accounts of any remarkable meteors that I may see here, I now notify one which appeared yesterday evening, April 13, at 20 minutes past 6 P.M. We were driving slowly home from Ansevata, near Noumea, when a splendid brilliant *pure white* meteor fell from the zenith, about 30°, quite perpendicularly and slowly. It burst into three pieces, and instantly disappeared. From Noumea its direction was due south, and in size it appeared four or five times larger than Venus. We heard no noise; the sound of the carriage wheels grinding on the road would have prevented any but a rather loud one being audible. It was not dark, but twilight.

We have been suffering much from unusual heat, and the atmosphere is surcharged with electricity. Heavy storms brew in the mountains, but we have been free from them here in Noumea. Heavy rain squalls gather to the southward, and on reaching the south point of New Caledonia either divide and run along the mountains on one side or the circling reef on the other, or also pass solidly in either direction, leaving the peninsula of Noumea perfectly dry. E. L. Layard

Brit. Consulate, Noumea, April 14

Intellect in Brutes

Mr. Romanes has alluded to some of the peculiarities of my feline pets, but really those are by no means the most striking instances of their intelligence. My wife and I are devotedly fond of our cats, so much so as to afford amusement to our friends, and we are never tired of expatiating on their indications of intelligence. A pedigree book is kept, and any reader of Nature desirous of possessing a kitten of an intelligent stock is welcome to one on three or four months' notice.

I wish to give one other story of them which seems to show that they are apt to indulge in revenge and to act in systematic co-operation to accomplish it. They are of very cleanly habits, and, save under the circumstances about to be narrated, have never given any trouble in this respect. But some time ago we had a visitor who had a strong and very badly-concealed dislike to them. The dislike was quite mutual. Very soon after the arrival of this visitor the cats became very objectionable on account of messes, and these were concentrated in and near the bedroom occupied by the object of their aversion. Their insanitary proceedings became so pronounced that it almost appeared as if they had invited all their feline friends in the neighbourhood to join in the establishment of a "night-soil tip." No amount of correction, aided by pepper of the most pungent kind, could stop it, and I most reluctantly determined upon a wholesale felicide. The visitor departed, however, before this was carried into effect, and immediately the nuisance ceased, and our cats resumed their original cleanly habits.

Lawson Tait

I have perused with interest the admirable summary of the "Animal Intelligence" question by Mr. Romanes. On reading the article in question, it occurred to me that I had at hand some memoranda concerning animal intelligence which bear on the presence, not merely of *abstract* reasoning in dogs, but also upon the presence in dogs of traits of character remarkably resembling those we are accustomed to name "retaliation" and "revenge" in man. I now send you the jottings in question, obtained, I may add, from personal friends. About thirteen years ago, a now deceased medical man residing near Edinburgh, possessed a favourite collie, "Cheviot" by name. The incident I am about to relate, I may mention, was related to me by the son of the gentleman in question, both father and son, along with a perfectly disinterested party, having corroborated the facts. The then provost of the burgh in which "Cheviot" resided, had issued an interdict against unmuzzled dogs during the "dog days," and "Cheviot" submitted with no good grace to the operation of securing his jaws. Frequently "Cheviot's" master and the members of the family spoke in the dog's hearing, in no measured terms of the cruelty of the provost's order. But the end of the "dog days" came, and "Cheviot's" muzzle was removed. On the afternoon of the day of liberation, the provost called on "Cheviot's" master, to say, that in the morning he had heard a dog whining at his front door. The provost opened the door; "Cheviot" was in waiting, his muzzle in his mouth. One look at the provost, and the muzzle was dropped at his feet, "Cheviot" scampering off in the highest glee, as if delighted to have had the opportunity of laying the cause of his grievance at the door of his enemy.

The details were vouched for by the provost himself, also a medical practitioner in the burgh.

Here it seems to me you possess an incident of dog character explicable only on the supposition that there are germs in the canine philosophy of acts and traits fully developed in ours.

Incident number two deals with the doings of a retriever, some four or five years old, who, whilst bearing an implacable enmity to felines at large, had struck up a close friendship with a household cat, which, from kittenhood, had been associated with him. For sanitary reasons the cat was condemned to die. According to the orthodox method, puss was placed in a sack weighted with stones, and carried to the sea, "Keeper," the dog, following in the wake of the procession. The cat was duly thrown into the sea, "Keeper" waited to see if it would rise, but on seeing no signs of his feline friend, he at once dived for the sack, and landed it at an adjacent pier. Being met by the executioners and divining that puss was yet in danger, "Keeper" re-entered the water, sack in mouth, and swam across the bay to a point of safety, and landed his burden. Puss was spared in deference to "Keeper's" anxiety.

I can find still another example of extreme unselfishness in a mongrel dog, who, for some years before the death of an old deaf and blind companion, was accustomed to proceed to his resting-place, and bark in his ear to warn him of the presence near at hand of the milk which the kindly hand of the mistress of the house was accustomed to place for the delectation of both. This proceeding was repeated day by day, with unvarying regularity, and in its nature suggests strongly that the exercise of self-denial—amidst the obvious temptation of an easy acquirement of luxury—has to be placed to the credit account of the canine race. Andrew Wilson

Edinburgh Medical School, June 6

With reference to the article in Nature of 5th June, permit me to narrate an instance of "abstract reasoning" in a retriever that I was witness to last autumn.

Having shot a hare so slightly as to make it a long chase for the dog (a young one), I watched the retriever follow the hare over the open hills of Aberdeenshire for upwards of two miles until the chase was lost to view under a stone dyke. In a few moments the dog was observed to carry something in his mouth with which he disappeared over the dyke into a turnip field. "He has killed the hare and he is too tired to bring it back, so he is burying it," quoth the keeper, "we shall come up with it in the evening." The day's sport over, we made for the dog's burying ground, but the retriever, if you please, knew nothing about it; and careered wildly about in every direction except the right one. The keeper, Henry Ledingham of Tarland, Aboyne, having a remarkable gift of spotting fallen game, actually put his foot on the very spot among the turnips where the burial had occurred. After immense affectation of surprise the retriever was forced to unearth the hare. The hare, however, was a rotten old carcass of a hare, with no eyes and teeth, that the retriever had picked up and buried to save himself the pains of following the live hare. Perfectly conscious of his misdeed, the dog had given evidence of abstract reasoning in each stage of the transaction.

Charles Baillie Hamilton

St. Stephen's Club, Westminster, June 10

I have followed the discussion in your columns on "Intellect in Brutes" attentively, and I maintain that Mr. Henslow's distinction between man's power of abstract reasoning, and the reasoning of animals from objects present to the senses (a faculty they certainly possess, if the theory of deductive reasoning, that all inference is from particulars to particulars be accepted, which, however, cannot be proved), is perfectly valid, in spite of any accidental errors of illustration.

The fact that a cat or a dog subject their food to examination before eating it, does not most assuredly prove the possession of abstract powers of thought in the animal. Mr. Romanes here says:—"The motive of the examination being to ascertain which general idea of quality is appropriate to the particular object examined."

Here he attributes to an animal whose nature he does not fully understand his own process of thought, and this appears to me to be a constant source of error in the investigation of animal psychology. That brutes possess self-consciousness, introspection, imagination, abstract thought, cannot, I think, be proved. The

fact that animals possess faculties differing from those of man is an insuperable obstacle to a perfect analysis of their intelligences.

Name these faculties as you please, call them "inherited habit," "inherited memory," it is perfectly certain that man does not possess them.

H. D. BARCLAY

WILLIAM FROUDE

THE death of Mr. W. Froude, F.R.S., is a loss to science that cannot well be estimated. For many years he laboured with great ability and success in a field of research that was beset with difficulties, and had previously been almost barren of results. He was educated at Westminster, and went from there to Oxford, where he distinguished himself in mathematics. After leaving Oxford he became a civil engineer, and assisted Mr. Brunel in railway and other engineering work. He retired from active professional life in 1846, but his love of applied science retained such a hold upon him that he never ceased to occupy himself with important scientific investigations, and the solution of practical problems of peculiar difficulty. His intimacy with Mr. Brunel led to his mind being directed towards the study of those laws of nature which govern the motion of floating bodies. Mr. Brunel had devoted himself, among other things, to the improvement and development of iron steamship construction. In the *Great Western* and *Great Britain* he had made great advances in this direction; while in the *Great Eastern* he showed that iron and steam power could be employed in the production of ships of practically unlimited dimensions, and that by means of these agencies all the advantages appertaining to increased size might be realised.

In designing ships of such exceptional character and dimensions, Mr. Brunel found little to guide him in judging of their behaviour at sea. They were so different to any vessels afloat whose behaviour and qualities might have been ascertained, that he was unable to appeal to experience, while the light of science was so feeble and doubtful as to afford him no aid. Nobody at that time knew anything of the laws upon which a ship's motion at sea depends. There was a large mass of traditional experience, but this was often at variance with fact, owing to phenomena which are familiar to seamen being regarded as absolute, and possessing a reality of existence as well as of appearance; while, as must be obvious, they are only relative in their character, and cannot be accurately defined without making due allowance for the position and motion of a ship, with reference to the sea. The rules and maxims that had been adopted upon such incorrect and distorted data, were either unimportant or misleading; they were of no value. Mr. Froude said, quite correctly, in 1861, that our shipbuilders, while extending their knowledge in other directions, seem to have guided themselves by rhetorical phrases or random speculations in this particular branch of their art, "so that when a new ship is sent to sea, her constructor has to watch her behaviour in a seaway, with as anxious and uncertain an eye as if she were an animal he had bred and was rearing, and hoped would turn out well, not a work which he had himself completed, and whose performance he could predict, in virtue of the principles he had acted on in its design."

Mr. Froude, at the request of Mr. Brunel, commenced in 1856 an investigation into the laws of motion of a ship among waves. This had been previously attempted by D. Bernouilli, Euler, Moseley, and others, but without success. None of these writers had realised the fundamental conditions of the action of wave-water upon a ship, viz., that the direction and intensity of the fluid-pressure at any point is continually changing, and that the direction of pressure is normal to the surface of equal pressure passing through that point. They based their theories upon hypotheses respecting wave-action that were all more or less erroneous, and prevented any useful result being realised. Mr. Froude's method of dealing with the subject was, first of all, to determine the manner in which a wave acts upon a ship; or, in other words, the mode of operation of the agency whose effects he wished to comprehend. In this he was completely successful, and proved in an unexceptionable manner the mechanical possibility of that form of motion known as the trochoidal sea-wave. On the assumption that the motion of each particle on the surface of a wave describes an exact circle, whose diameter is the height of the wave from hollow to crest—which agrees with the results of observation—and that the motions of all particles lie in vertical planes which cut the wave-ridges at right angles, he deduced the theory that the form of the wave would be trochoidal, and that the periodic time would be equal to the time occupied by a heavy body in falling through a height equal to the circumference of a circle whose diameter is the length of a wave. It also followed that all sub-surfaces of equal pressure would be trochoids of the same length as the surface-wave, but of a height which would diminish with the depth in accordance with the equation $\frac{r_o}{r_d} = e^{\frac{\pi}{L}d}$, where e is the base of Napierian logarithms, L the length of the wave from hollow to crest, d the depth of the centre of the circle described by any particle below that of the circle described by the surface-particle, r_d the radius of the circle at the depth d, and r_o that of the circle at the surface. Prof. Rankine also independently deduced the same theory. A striking feature of the investigation was the rapid decrease in the motions of the particles as they are traced to lower depths. Prof. Stokes showed that for all waves of ordinary proportions, the motion at a depth equal to the length of the whole wave from crest to crest is only $\frac{1}{535}$ of that which belongs to a surface particle. The dynamical conditions of wave-water being thoroughly investigated and established, Mr. Froude next proceeded to base upon it a scientific theory of the rolling of ships among waves.

The subject was first brought before the public by Mr. Froude in a paper read before the Institution of Naval Architects in 1861. He stated that he felt some diffidence in bringing forward "what assumes to be a tolerably complete theoretical elucidation of a difficult and intricate subject, which has hitherto been treated as if unapproachable by the methods of regular investigation." He pointed out that the characteristic feature of the dynamical laws to which it would be necessary to refer the movements of a ship when rolling is the gradual accumulation of angle during several successive rolls, the cumulative action thus growing up into a maximum, and then dying out by very similar gradations until the ship becomes for a moment steady, when a nearly similar series of excursions commences and is reproduced; while in reference to the momentary pause, or cessation of motion, it seems clear that it occurs, not because the waves themselves cease, or cease to act, but because the last oscillation has died out at a moment when the ship and the waves have come to occupy, relatively, a position of momentary equilibrium. This is so closely analogous to what happens when a pendulum is subjected to a series of impulses, partially synchronous with its own excursions, that it seemed probable that the laws which govern the latter class of phenomena would be found, *mutatis mutandis*, applicable to the elucidation of the former also. The investigation of the laws of rolling motion, when thus regarded, therefore assumed the form of the inquiry, "What is the cumulative result of the continuous action of a series of consecutive waves operating on a given ship?"

In order to determine this it was necessary first to determine how each individual wave will act upon a ship at each instant of time; or, in other words, "What is the position of momentary equilibrium for a body floating on a wave, and what accelerating force towards that position

will the body experience in terms of her momentary deviation from it?" Mr. Froude has demonstrated both *à priori* and experimentally that to a stabilised particle floating at any point on the upper surface of a wave, the position of momentary equilibrium is that which would place the axis of equilibrium normal to the wave surface at the point where it floats, and that to another similar particle, floating or suspended below the surface, the position of momentary equilibrium is that which would place the axis normal to the sub-surface of equal pressure passing through the point where it is placed. If we take account of the aggregation of particles which a ship displaces, and for which she herself is substituted, and of which she accepts the aggregate dynamic condition, we know that her position of momentary equilibrium must be the mean of the positions belonging to the various particles displaced; and we may assume, with a close approximation to the truth, that this is the position which would place her axis of equilibrium, or her masts, at right angles to one of the wave sub-surfaces of equal pressure.

The sub-surface of equal pressure through the centre of gravity of a ship's displacement may be regarded in theory as a sufficiently close approximation to the effective wave surface; and it follows that when a ship deviates from the normal to this surface the effort by which she endeavours to conform to it depends upon the momentary angle of deviation in the same manner as her effort to assume an upright position when inclined in still water depends on the angle of inclination. Hence her stability or effort to become vertical in still water, measures her effort to become normal to the effective wave surface in wave water. The equations of motion for a floating body, oscillating in still water, which had previously been investigated, could therefore be applied to undulating water by introducing the condition that the position of equilibrium changed with the direction of the wave slope. Mr. Froude was not able, at first, to solve the resulting equation by adopting the trochoidal hypothesis. He therefore substituted the curve of sines for the trochoid, which gave him a form of equation he could deal with. Prof. Rankine afterwards solved the equation obtained by using the trochoid, but the results agreed with those arrived at by Mr. Froude under the conditions to which the investigations applied.

The assumptions made in order to adapt the problem to mathematical treatment were (1) that the ship is rolling passively in the trough of the sea; (2) that she is exposed to a regular series of similar waves; (3) that the waves are so large as compared with the ship that she may be assumed to accept the motion of the part of the wave she displaces; (4) that the variations of apparent weight may be neglected in comparison with the actual weight; (5) that the ship is of such a form as to make her still water oscillations isochronous—this being approximately the form of the old line of battle ships; and (6) that the rolling is unresisted—the effects of resistance in modifying the motion being separately considered.

The equations thus obtained by Mr. Froude, representing the oscillations of a ship among waves as compared with those performed in still water, are most interesting; but our space will not admit of giving a full analysis of them. Their general character may, however, be appreciated if we call attention to some of their most striking features.

One critical case is that of a ship rolling among waves, whose periodic time synchronises with her own time of oscillation. It may be readily deduced from Mr. Froude's fundamental equations that, if it were not for the resistance to rolling caused by surface friction and form, a ship placed broadside on to waves which have her own periodic time, must ultimately roll completely over, however small the wave may be. It is not uncommon to find the length of a half-wave ten times the height. Such waves would increase the angle of roll by 14·1° at each inclination, so that six successive impulses, or three complete waves, passing a ship would produce almost a complete overset. Though this conclusion requires to be greatly limited by introducing the element of resistance, it is obvious that such synchronism of wave-period and ship's-period must produce most formidable effects. Mr. Froude produced the result thus indicated by his theory by direct experiment with floating bodies of such form as would give approximate cases of unresisted rolling. He immersed a sphere to two-thirds of its radius; a prolate spheroid to about the same proportion of its major axis; and a body like a flattened orange was wholly immersed, having only a very narrow neck projecting from it above the water-level, like the stem of a hydrometer. By an ingenious arrangement for regulating the period of the waves it was found that, when the oscillations of the floats and the wave-period were made to synchronise, all the floats were upset after the transit of a very few waves, while a very small change in the natural period of one of the floats, made by slightly altering the position of its centre of gravity, made its behaviour plainly exceptional as compared with the two others. It now refused to be completely overset by the series of waves which would upset the two others almost at the same moment, though it was itself overset by a series slightly quickened or retarded according as its own period was quickened or retarded by the altered position of its centre of gravity, the other two being at the same time released from all danger of capsizing.

Another critical case is when the ship possesses infinite stability; or an infinitely small radius of gyration or moment of inertia. This is not a practical possibility, but is noticed on account of the indication it gives of a ship's tendencies according to the degree in which it may possibly be approached. In this case the ship will be perfectly quick in her movements and will follow precisely the slope of the wave. The movements of a flat board laid on the water are a practical illustration of this condition. The periodic time of such a board may be practically treated as = 0; and if a ship could be so constructed as to fulfil this condition, there might be some wisdom in attempting it. It is impossible, however, to construct a ship that will even approximately fulfil this condition, and as an approach to it could only be effected by giving her the greatest possible stability, she would only the oftener meet waves with which she would synchronise and experience the evil consequences of that condition.

One other critical case, the conditions for which are deducible from the equation of rolling motion, is that in which a vessel exposed to a series of waves performs her oscillations not in her own period but in that of the somewhat different wave period. In this case the still water oscillations would not synchronise with the wave period; but a relation subsists which enables the increasing slope of each wave to just counteract the growing inclination of the ship. At the wave hollow and crest a ship under such conditions would be upright: and she would reach her greatest inclination to the vertical when she was in an intermediate position upon the greatest slope of the wave. She would roll so that her masts would always lean towards the wave.

A general feature of the theory as deduced from the equation of rolling motion is that when the natural time of oscillation of a ship and the wave period do not synchronise, and when the rolling has not become permanent, the ship's oscillations will pass through phases analogous to the action of a pendulum when subjected to a series of impulses partially synchronous with its own excursions; and, as we have seen, this deduction is in accordance with the observed phenomena of rolling.

The results given by Mr. Froude's equation for unresisted rolling give, so far as character is concerned, a generally correct view of what actually occurs. But, quantitatively, the angles of oscillation indicated are

largely in excess of the truth. A most important practical circumstance is left entirely out of account in the equation, viz., the fact that the oscillations are performed in a resisting medium. The laws of resistance to rolling are not sufficiently well understood to enable their modifying effect to be introduced into a general equation, and a direct and theoretical solution of the question thus attempted. Mr. Froude has shown, however, how in the case of any individual ship an approximate solution may be obtained with certainty by help of data derived from a single experiment with the ship herself, or even with a carefully made model of her, tried in still water. He has also pointed out that if a well-selected series of such experiments were tried for ships of different forms, and the results tabulated, the series of corresponding solutions would enable him to determine, as if *à priori*, what modifications the results of his equation would require for any ship whatever.

The resistance which a ship experiences in oscillating through a given angle among waves is practically the same as it would be if she were performing an oscillation of the same range in still water. If she is set rolling in still water the resistance will rapidly bring her to rest when the force which caused her to roll ceases to act. In the same way, when rolling among waves, the same resistance will reduce the angles of oscillation. It is this circumstance which prevents dangerous angles being reached in the critical case of synchronism, and which, at all times, fixes the limiting position to which a ship will roll. The action of the waves in increasing the angle of roll is balanced by the opposing tendency of resistance to reduce it. The aggregate resistance of a ship to rolling is made up of three parts: (1) That due to the friction of the fluid in moving over the skin of the ship; (2) the direct resistance of the keel and fine parts at the ends to being pushed through the water at right angles, or nearly so, to their planes; and (3) what Mr. Froude calls the "wave-making function," or the element of resistance caused by the successive displacements of fluid in rolling which affect the surface as waves, and travel away from the ship, thus abstracting from her the energy they embody.

The aggregate resistance to rolling being of such a character, and containing elements which vary in different ways with the rate of motion of the surface of a ship's bottom, its exact computation in a particular case would be very difficult. Mr. Froude has, however, done much towards enabling a sufficiently close approximation to be arrived at by direct calculation. For practical purposes, however, Mr. Froude's original suggestion of determining the amount of resistance by still water experiments is employed. A ship is set rolling in still water, and upon reaching an angle of sufficient magnitude, she is allowed to come to rest under the action of resistance only. The rate of extinction of her range of oscillation is continuously noted and registered in the form of a curve. It will be obvious that the difference in amplitude of two successive swings measures the aggregate effect of the resistances operating upon the ship, and that by means of a complete curve of extinction a measure of the resistance opposed by her to rolling among waves may be obtained.

This is, necessarily, but a general description of Mr. Froude's theory, and does not include many details and some collateral matter which are of importance in making it quite complete; but it will serve to give an indication of its broad features.

Mr. Froude's theory has met with general acceptance as being a sufficiently close approximation to a correct expression of the laws of motion of a floating body among waves. Some of the departures from absolute accuracy contained in the assumptions necessary to the formation of the theory, such as that wave-water is continually changing its form, and a ship being a rigid body, cannot therefore, strictly speaking, be said to accept the dynamical conditions of the displaced fluid as it accepts the statical conditions of its still-water displacement; and the objection that a sub-surface of equal pressure does not correctly represent the effective wave surface have been criticised; but the criticisms have only shown that the errors thus involved are very small in amount and have no appreciable effect upon the general results of the theory. Mr. Froude has always insisted himself upon the existence of imperfections in his theory, but he has constantly been at work upon their removal, and upon the determination of the tangible amount of error they introduce into the ultimate result.

Mr. Froude's work was undertaken at first with a practical object, on account of Mr. Brunel's requirements, and it has already accomplished great practical results. It has led to the conclusion that ships of long periods are least likely to meet with waves which will cause them to roll heavily, and that the rolling of a ship can be greatly reduced by means of deep-bilge keels. These ideas have been extensively acted upon in H.M. Service. Our heavy armour-clads and other ships of war have been designed in accordance with this theory, so as to have great steadiness at sea, and in many special cases their properties have been determined by Mr. Froude beforehand, so that instead of working in the dark the Admiralty have known what behaviour to expect from a ship after she is built. The effect of bilge-keels in extinguishing rolling was clearly shown by Mr. Froude in 1871, with a model of the *Devastation*. Without bilge-keels the model performed 31½ complete oscillations before coming to rest in still water, after being inclined to an angle of 8½°, but with a bilge-keel equivalent to 36 inches in depth on the full scale of the ship, she came to rest in eight oscillations, and with a bilge keel double this depth she came to rest in four oscillations. The same model when tried among waves which capsized her when no bilge keels were fitted only rolled to an angle of 13½° with 3 feet bilge keels, and to 5° with 6 feet bilge keels. These experiments showed conclusively the effect of bilge keels in limiting the range of oscillation among waves.

The importance of bilge keels was further tested by comparative trials conducted by Mr. Froude off Plymouth in 1872 between H.M. ships *Greyhound* and *Perseus*—both of the same class—the former having bilge keels and the latter being without them. Mr. Froude also conducted an elaborate series of experiments on board the *Devastation* at sea in 1873 and 1875, and, by means of a most ingenious machine of his own construction, obtained continuous automatic records of her behaviour. These records showed (1) the relative inclination of the ship and the effective wave slope at any instant; (2) the inclination of the ship to the vertical at any instant; and (3) the period of oscillation of the ship at any time, that is, the number of seconds occupied in completing the roll from port to starboard, and *vice versâ*. From the diagrams upon which (1) and (2) are traced in the form of curves Mr. Froude deduced, as a differential result, the period and angle of slope of the effective wave surface at any instant, thus determining it with a much greater degree of exactness than that with which the form of a surface wave could be ascertained.

Mr. Froude was constantly checking and correcting his theoretical results by the aid of experiment, and though he had succeeded in fully establishing the true theory of the rolling of ships among waves, he did not rest satisfied with his success, but had recently made arrangements at his experimenting tank at Torquay for proceeding with further important lines of investigation by means of observations upon the behaviour of models in waves mechanically generated.

We have only dealt with Mr. Froude's labours in connection with the question of the rolling of ships in this number, and must reserve a description of his investigations into the laws of resistance and propulsion, which are at least of equal importance, for another occasion.

(*To be continued.*)

THE COLD WEATHER OF LAST WINTER AND SPRING

THE winter and spring just past will be historically memorable for the unprecedentedly cold weather which has been the outstanding characteristic. More intense cold has no doubt been experienced in former years for single nights, or for brief intervals of a few days, than has been recorded anywhere in these islands during the past six months; but for upwards of a century since thermometric observations of the temperature of the air began to be made in Great Britain there has not occurred, so far as these observations show, a tract of weather so cold, as respects duration and intensity combined, as has prevailed during the half year ending with May.

From January, 1764, we have a consecutive series of monthly mean temperatures before us from observations made on the south shores of the Moray Firth and of the Firth of Forth. From this unique and valuable record we give the following periods of protracted low temperatures extending over intervals of from five to ten months, which have occurred in North Britain during the past 115 years, the amount of the depression below the means of the months being at least three degrees:—

Date of Cold.	Duration in months.	Under mean temperature of the months.
		°
February–November, 1782	10	−5·1
January–August, 1799	7	−3·8
October–March, 1799–1800	6	−3·3
November-April, 1807–8	6	−3·5
March–August, 1812	6	−3·4
October–March, 1813–14	6	−3·6
November–August, 1815-16	10	−3·5
January–May, 1838	5	−4·2
January–May, 1855	5	−3·5
December-April, 1859–60	5	−3·0

Of these periods the most intense and, excepting that of 1815-16, the most protracted cold was that of 1782, when, during the ten months beginning with February, the temperature was 5°·1 under the mean of these months, the deficiency being 5°·4 for the five months from February to June, and 4°·8 from July to November. It may be noted that of these ten periods of protracted cold weather none occurred from 1764 to 1781; there were no fewer than seven during the next thirty-four years, and during the sixty-three years which have elapsed since 1816, only three such cold periods have been recorded.

Happily the extraordinary development and extension of meteorological observation which has taken place in late years enables us to define with some precision the distribution of the great cold of 1878–79 over the British Isles. For this purpose we have selected ninety-two places well distributed over the United Kingdom, and calculated their mean temperatures for the six months from December to May, and compared them with Buchan's mean temperatures and isothermals of the British Isles.

From the results thus obtained, it appears that this cold weather was felt in its greatest intensity in Central Enlgand, where, within a circuit roughly defined by a line passing near Stonyhurst, Shrewsbury, Cirencester, Oxford, Audley End, Yarmouth, Kelstern in Lincolnshire, and Durham, the depression of the temperature below the means of the six months exceeded 6°·0, falling to 6°·7 below the average at Cirencester and 7°·4 at Shrewsbury. Large portions of the south of Scotland between the Solway and the Firth of Forth and in Perthshire had also a mean temperature for the period fully 6°·0 under the average. Northwards through Central Scotland as far as Lairg in Sutherland, the depression of temperature was only about 5°·0 below the average; and this appears to have been about the deficiency experienced over central Ireland, falling, however, to 5°·7 at Armagh, and 5°·3 at Lissan, on the west of Loch Neagh. Everywhere round the coast the cold was less intense than in the interior. Temperatures were from a degree to a degree and a half relatively milder along the east coast, and still milder on the west coast; indeed, Shetland, Orkney, the Hebrides, the south of Ireland, Scilly, and the Channel Isles had a mean temperature only from 2°·0 to 3°·0 below the average temperature of the period, so greatly was the conserving influence of the ocean felt on the temperature of places in the west and south during this memorable cold weather.

During these six months, the greatest depression of temperature, absolutely as well as relatively to the monthly means, took place in December and January. If the monthly means be only looked at, the absolutely greatest temperature depression during the period was in December, in the counties of Cumberland and Dumfries, and along the upper reaches of the Tweed and Clyde, with their affluents. Within this region the mean temperature of December, reduced to sea-level, did not rise above 29°·0, falling at some places as low even as 27°·5. The week of intensest cold was the second week of December, when the mean temperature fell at many places in England, Scotland, and Ireland, to from 15°·0 to 18°·0 below the average of the season.

If we look at the monthly mean temperatures of the past 115 years as compared with their averages, with the view of ascertaining the duration of the most protracted periods of cold weather which have occurred during this long interval of years, defining as a period of cold weather an interval of time during which the mean temperatures of the months were continuously under their averages, we find that there have occurred four such noteworthy periods of protracted cold weather, during which the mean temperature of no month included in it rose above its average. These, arranged in the order of their duration, are (1) A period of 19 months, extending from September, 1798, to March, 1800, the mean temperature of this long period being 2°·8 below the average; (2) A period of 17 months from September, 1859, to January, 1861, which was 2°·2 below the average; (3) A period of 15 months, from October, 1815, to December, 1816, which was 3°·0 below the average; and (4) A period of 14 months, from February, 1782, to March, 1783, the mean temperature of which fell 4°·4 below the average of the months. It is thus only too evident that while the cold weather most of us have been suffering from these six months exceeds in intensity any other past period of cold weather in these islands of like duration of which we have an exact and authentic record, the temperature observations of the past 115 years disclose to us tracts of unseasonably cold weather, two or even three times more protracted than the interval which has yet elapsed since the present cold set in with such intensity and persistence in November last.

THE ICE CAVERN OF DOBSCHAU[1]

WHILE on a tour in Hungary last summer I had the opportunity of visiting an ice cavern near the town of Dobschau; the discoverer of the cavern kindly conducted me through it and wished me to make it known to the English public; with this object in view I have written the following short account:—

The cavern is situated to the north-west of Dobschau, and is approached through a narrow winding limestone valley, "the Stracenaer Thal." It has a general direction from west to east in the interior of a mountain whose slope faces north; the descent into it varies from oblique to precipitous, the entrance, which is very narrow, being situated at the highest point of the cavern; the ice consists of innumerable layers frozen together one upon the

[1] Dobschau is situated a little to the south of the Kaschau-Oderberger-Bahn, the nearest station on that line being Iglo.

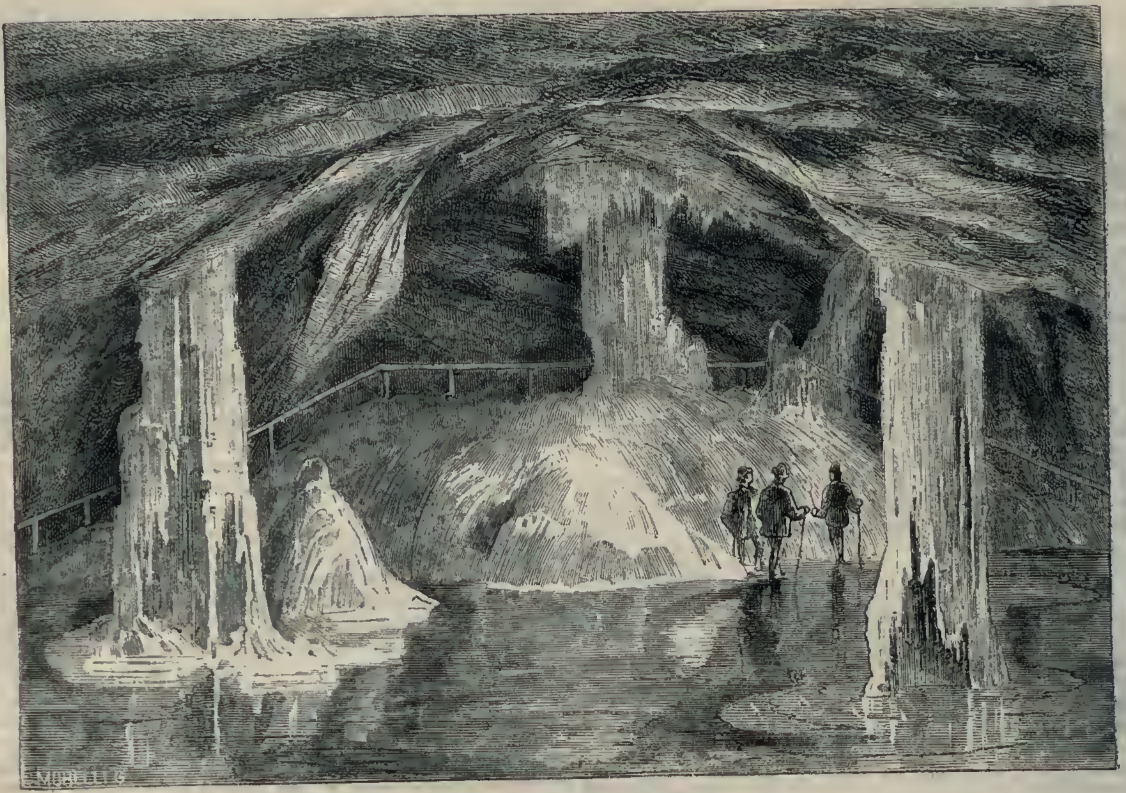


Fig. 1.—Portion of the Great Saloon.

Fig. 2.—The Corridor.

other, and assuming various fantastic shapes. The total surface of ice and rock is 8,874 square metres, that of the former being 7,171 square metres, of the latter 1,703 square metres; the mass of the ice amounts to 125,000 cubic metres.

The cavern consists of two parts, an upper and lower stage; the former is reached immediately after leaving the entrance, its floor being formed of ice, its roof and walls of limestone; it is partially divided into two unequal chambers, the small and great saloons (Fig. 1), by a curtain of rock descending from the roof. The small saloon is not situated on the same level as the great saloon. In the great saloon are three ice pillars (Fig. 1); they are translucent, and down the cylindrical hollow of one pillar there is a continuous though small flow of water; in addition there are numerous other ice ornaments which have received fanciful names. The eastern end of the saloon is contracted into a very narrow corner; at this point there has been a landslip corresponding to a crater-shaped depression in the slope of the Duosa Mountain, in which the cavern is situated. In the small saloon to the right of the entrance is a waterfall composed entirely of ice.

The lower stage consists of a corridor (Fig. 2) following the south side wall of the saloon; the downward prolongation of the dome-shaped rock wall of the saloon forms the south corridor wall, while the naturally formed cross-section of the ice constitutes the northern. The corridor originally consisted of two portions, a right and left wing, separated by a mass of ice; this has now been bored through. The entire length of the corridor is 200 metres.

The right corridor wing is reached from the small saloon by going down a steep flight of steps through a natural opening; the mass of ice whose upper surface forms the floor of the saloon after touching the roof suddenly terminates so as to make a nearly vertical wall to the corridor; the floor of the latter sinks down into the depths below, terminating in a mass of *débris*; this point probably forms a natural outlet for the water.

In the left corridor-wing is a magnificent ice structure termed the Grotto (Fig. 3).

The cooling of the air and the permanent low temperature (the mean of the year being $-\cdot86°$ C.) of the cavern are due to its height and northern aspect, as well as to its narrow opening and contracted exit canal, and to its floor gradually sloping inwards; as a result of this, the water is converted into ice, and the permanence of the latter thus insured.

Through the kindness of Herr Ruffiny, the discoverer, and Dr. Pelech, I have been enabled to obtain the loan of the woodcuts.

W. BEZANT LOWE

FIG. 3.—The Grotto.

THE VISITATION OF THE ROYAL OBSERVATORY

ON Saturday last the annual visitation of the Royal Observatory was held, when the Astronomer-Royal read his annual report, which refers to a period of thirteen lunations, from the new moon of 1878, May 2, to the new moon of 1879, May 20. We notice some of the most important points in this report:—

Considerable alterations have been made in the great equatorial, so as to make the instrument easy for use with the long half-prism spectroscope. The declination axis being meridionally excentric by 14 inches as regards the polar axis, the observing-chair may be made available for eye-observations and for spectroscopic observations respectively, by reversing the instrument in hour-angle so as to take advantage of this excentricity.

With regard to the numerous group of minor planets, the Berlin authorities have most kindly given attention to the Astronomer-Royal's representation, and we have now a most admirable and comprehensive ephemeris.

The meridian observations of stars are directed primarily to the determination, with the greatest attainable accuracy, of the places of 215 fundamental stars observed throughout the day and night, and these are supplemented by observations of stars taken from a working catalogue of about 2,500 stars. About 1,300 of these stars were observed in 1878, forming a larger annual catalogue than usual.

As might have been expected, the Astronomer-Royal's report on the weather of the past year is not satisfactory. After a fine autumn, the weather in the past winter and spring has been remarkably bad. More than an entire lunation was lost with the transit-circle, no observation of the moon on the meridian having been possible between January 8 and March 1, a period of more than seven weeks. Neither sun nor stars were visible for eleven days, during which period the clock-times were carried on entirely by the preceding rate of the clock. The accumulated error at the end of this time did not exceed 0s.·3.

"During the past year, spectroscopic observations have been almost entirely suspended, in order that the reductions of accumulated photographic observations might proceed more rapidly. The sun's chromosphere has been examined on seven days only, and, on five of these, prominences were seen. Two measures of the displacement of the F-line in the spectrum of α Virginis, and 26 of the *b* lines in the spectra of 6 stars (3 of them not previously examined), as compared with the corresponding lines of hydrogen and magnesium, have been made. In five of these, though the stars were of the second magnitude only, a dispersive power equivalent to fifteen prisms of 60° was used. These observations were checked by reference to the F or *b* lines in the spectrum of the moon or of the sky. The spectrum of Brorsen's comet has been examined with the half-prism spectroscope, and that of the eclipsed moon on 1868, August 12, with the single-prism spectroscope.

"Photographs of the sun have been taken on 150 days, and 228 of these have been selected for preservation. The photographs show a complete absence of spots on 121 days out of 150; and on comparing them with those of the preceding year, when there was an absence of spots on 66 days out of 156, it appears that we have not yet passed the minimum.

"The following are the principal results for magnetic elements in the year 1878:—

Approximate mean westerly declination	18° 49′.
Mean horizontal force ...	3·905 (in English units). 1·801 (in Metric units).
Mean dip	67° 37′ 10″ (by 9-inch needles). 67 38 12 (by 6-inch needles). 67 38 59 (by 3-inch needles).

"The magnetic reductions for the years 1865 to 1876 are nearly completed. The results are exhibited in the form of annual and monthly mean curves of diurnal inequality, as in preceding investigations, the abscissæ showing the variation of magnetic declination, and the ordinates that of horizontal force, throughout the twenty-four hours. The annual curves of diurnal inequality are now complete for the period of thirty-six years, from 1841 to 1876; and from the great length of this series of observations," the Astronomer-Royal goes on to say, "all made on the same system and with similar instruments, most important inferences may be drawn, both as to the laws of diurnal inequality in general and its changes in different years and seasons, and as to the connection between magnetic phenomena and sun-spots. These annual curves show a well-marked change in close correspondence with the number of sun-spots. About the epoch of maximum of sun-spots they are large and nearly circular, having the same character as the curves for the summer months; whilst about the time of sun-spot minimum they are small and lemniscate-shaped, with a striking resemblance to the curves for the winter months. We think with the Astronomer-Royal that it may be worthy the consideration of the Board whether the whole of these results, with any modifications that experience suggests, should not be printed and circulated as a separate volume.

"The monthly curves, 1865-76, have been formed for three periods of four years each, corresponding roughly to periods of minimum, maximum, and mean of sun-spots, and the whole series stands thus (the general character of the curves being added):—1841-47 (curves) mean; 1848-57, small; 1858-63, large in summer, small in winter; 1865-68, small; 1869-72, very large; 1873-76, mean. The maxima of sun-spots occurred in 1848, 1860, and 1870, and the minima in 1844, 1856, and probably in 1879.

"The connection between changes of terrestrial magnetism and sun-spots," the Astronomer-Royal states, 'is shown in a still more striking manner by a comparison which Mr. Ellis has made between the monthly means of the diurnal range of declination and horizontal force, and Dr. R. Wolf's "relative numbers" for frequency of sun-spots. It appears from this that not only is there a general correspondence in the two sets of phenomena, but that the minor irregularities of the sun-spot curve are reproduced in the curves of diurnal magnetic range; and further that the well-marked annual inequality in the latter is itself variable, being greatest at the time of maximum of sun-spots and least at that of minimum. It will be an interesting inquiry, when sun-spots become more numerous, to determine whether the present paucity of earth-currents is connected with the fewness of spots."

The Astronomer-Royal, by these researches, has endorsed the work we owe to Sabine, Broun, Stewart, and others.

The Report states that the Westminster clock has not been quite so well regulated as usual. During the period to which this Report refers, its error exceeded 1s. on 77 days; on 15 of these it was between 2s. and 3s., on 4 between 3s. and 4s., and on 1 day it exceeded 4s.

With regard to the last Transit of Venus results, the past year has been occupied in putting reports and calculations in a shape adapted to eventual printing of the account of the whole enterprise. With regard to the Transit of 1882, the Astronomer-Royal informs us that the general impression appears to be that it will be best to confine observations to simple telescopic observations or mcirometer observations at ingress and egress, if possible at places whose longitudes are known. For the first phenomenon (accelerated ingress) the choice of stations is not good; but for the other phenomena (retarded ingress, accelerated egress, retarded egress), there appears to be no difficulty. The adoption of a south-polar station seems to be practically abandoned.

With regard to the numerical lunar theory, the Report states that the incessant pressure of the business of the observatory has prevented the Astronomer-Royal advancing so rapidly as he had hoped. "The solar perturbing forces are all computed to 10^{-7} in all cases, and to 10^{-8} and 10^{-9} in those cases in which large factors are introduced by theory as necessary for obtaining the correction to tabular coefficients from discordance of computed deductions (lunar places on one side, with solar forces on the other). The lunar places with the same arguments, first computed to 10^{-7}, are now extended to 10^{-8} or 10^{-9}, for the powers of radius vector. The computations of the same kind for the other assumed elements (longitude and latitude) are not begun. In regard to the discordance of annual equation, to which I called attention in the last Report, I suspend my judgment. I have now discussed the theory completely; and, in going into details of secular changes, I am at this time engaged on that which is the foundation of all, namely, the change of

excentricity of the solar orbit, and its result in producing lunar acceleration."

With reference to the practicability of reducing the extent of the printed volume of "Greenwich Observations," the report concludes with some of the suggestions that have been made by certain members of the Board. The introduction, it has been suggested, might to some extent be stereotyped. No reduction, it is thought, should be made, in regard to the details of meridional and altazimuth observations.

To the strong appeal made for extension of the spectroscopic observation of stars, in reference to their motion in the line of sight, the Astronomer-Royal has given a tacit response by the modification of the S. E. Equatorial, so as to facilitate that extension. "The tendency of external scientific movement," he remarks, "is to give great attention to the phenomena of the solar disk (in which this observatory ought undoubtedly to bear its part). And I personally am most unwilling to recede from the existing course of magnetical and meteorological observations. All these, however, are inferior in importance, with regard to the question now before us, to the extent of printing the original details of astronomical observations."

"The general tendency of these considerations is," the report concludes, "to increase the annual expenses of the Observatory. And so it has been, almost continuously, for the last forty-two years. The annual ordinary expenses are now between two and a half and three times as great as in my first years at the Royal Observatory. I would fain flatter myself that the value of its results has increased in a greater degree."

NATURAL SCIENCE DEGREES AT OXFORD

DR. ODLING, replying in the *Times* to Canon Liddon's letter, referred to in NATURE, vol. xx. p. 132, maintains that unless some little Greek is considered absolutely essential to a liberal education, there can be no ground for refusing a degree in arts to students who, though unacquainted with Greek, are familiar with such like studies as geometry, arithmetic, and astronomy, which equally with grammar, dialectics, and rhetoric, have been counted from time immemorial among the liberal arts. And assuming the compulsory modicum of Greek now brought up by mathematical and natural science students to be a non-essential element of their liberal education, as certified to by a degree in arts, how can a degree in arts be hereafter refused to advanced students of either of these subjects who, while still bringing up Latin, shall in future offer a considerable amount of German, together with some amount of both mathematics and natural science as a substitute for the present modicum of Greek?

Dr. Odling, rather than degrade science by awarding its graduates an inferior degree, seems disposed to retain the little modicum of Greek at present required for a pass; he would have been contented with Canon Liddon if the existing arrangements had been undisturbed. His objection is not to the incubus of Greek, but to the slur about to be put on natural science.

Canon Liddon replies that, in speaking of the educational advantages of Greek, he was in part thinking of the *minimum*. He believes Dr. Odling mistaken in thinking that the new degree was intended as anything but an honourable distinction. No one could suppose, he believes, that the majority of the present Council could be unfriendly to physical science. The statute appeared to him to be drawn almost exclusively in the interests of natural science students, and with a view to relieving them of an uncongenial study.

In a subsequent letter Dr. Odling quotes a passage from a lecture delivered by Dr. Whewell some twenty-five years ago. In the course of showing that the great contributions made to intellectual education by Greece, Rome, and modern Europe in succession have been geometry, jurisprudence, and physical science respectively, he wrote as follows:—

"Our intellectual education now, to be worthy of the time, ought to include in its compass elements contributed to it by every one of the great epochs of mental energy which the world has seen. . . . A mind well disciplined in elementary geometry and in general jurisprudence would be as well prepared as mere discipline can make a mind for most trains of human speculation and reasoning. . . . But however perfectly the habits of deduction may be taught by these studies, such teaching cannot, according to the enlarged views of modern times, compose a complete intellectual culture. . . . As the best sciences which the ancient world framed supplied the best elements of intellectual education up to modern times, so the grand step by which, in modern times, science has sprung up into a magnitude and majesty far superior to her ancient dimensions should exercise its influence upon modern education, and contribute its proper result to modern intellectual culture."

Happily the further discussion has been postponed until Michaelmas Term; by that time it is hoped that some method will be found by which natural science will be honoured without hurting the feelings of any one. We may state that the Council of the Cambridge Senate recommend to the Commissioners that power be given in the statute to recommend degrees in science (B.Sc., M.Sc., D.Sc.).

ON SOME MARINE ALGÆ[1]

THE successor of Harvey in the Chair of Botany in the University of Dublin has taken, as his eminent predecessor did, the algæ for the principal object of his study. In 1877 Dr. E. P. Wright published in the *Transactions* (vol. xxvi. Science) of the Royal Irish Academy two memoirs, one on a green unicellular alga (*Chlorochytrium Cohnii*) parasitic in the mucous tubes of some diatoms, in *Polysiphonia urceolata*, and in *Calothrix confervicola*; the other on a parasite deprived of chlorophyll (*Rhizophydium Dicksonii*), which develops itself in the cells of an Ectocarpus, and which has been taken, at least in one case (*E. crinitus*, Harv.), for the fruit of an Ectocarpus. This present year the *Transactions* of the same Academy contain two additional memoirs by the same author, which are accompanied by three coloured plates drawn by Tuffen West. The latter memoirs seem to me to be conceived in a spirit, and executed after a manner, which one does not always meet with in the writings of the British algologists. Dr. Wright has studied the living plants, an innovation on which he cannot be too much congratulated. One would only wish that his exact and minute observations on the development of organs, a subject in which he has shown himself at home, had been joined to an experimental determination of their functions, a determination which morphology by itself is powerless to declare to us. It is easy to prove this latter statement by a few instances taken from authors whose abilities have been placed beyond all doubt. Thus it has been said over and over again—Naegeli himself believes it ("Algensysteme," p. 134, Pl. 1, Fig. 34; 6)—that the heterocysts of the Nostocs are reproductive bodies, while experiments the most easily made prove that they are nothing of the sort. Cramer ("Phys. syst. Untersuch. über die Ceramieen," Heft 1, p. 125) has mistaken the antheridia of Bonnemaisonia for young cystocarps. Dr. Wright has, as we will show further on, been himself the victim of a similar error. Morphology is not like the spear of Achilles; it does not heal the wounds which it makes.

Griffithsia setacea is a pretty, red alga, well known to

[1] From the French of Ed. Bornet.

all collectors of marine plants. It is composed of branched filaments made up of large cylindrical cells placed end to end in a single row. When it is in fruit, the filaments are furnished with short branches terminated by a globular involucre, in the interior of which are ranged the reproductive bodies. How are these formed, and how do these filaments and appendages grow? What modifications do the cell-contents experience during this formation and growth? These are the points explained with a good deal of clearness by Dr. Wright in the first of the two latter memoirs referred to (on the cell-structure of *G. setacea*, and on the development of its antheridia and tetraspores). Referring to the memoir itself for details, I would only call attention to a peculiarity noticed in the development of the involucre. The rays which compose it take their origin in a circle from the penultimate cells of particular ramuli, formed by a small number of cells and slightly club-shaped at their superior extremity. These rays are not all at once free. Detached from the protoplasmic mass on which the apical cell reposes, they for a long time increase underneath the common membrane which clothes the frond, and they are only made free somewhat later on by the rupture of this membrane. First of all figured, but very imperfectly by Derbes and Solier, well represented from life by Thuret, this peculiar disposition is shown by Dr. Wright as made clear by the use of reagents, and it would appear to be equally met with in the genus Pandorea, recently described by J. Agardh.

In following from their first appearance the development of the reproductive organs on the rays of the involucre, Dr. Wright observed that the cells destined by their origin and their position to form the tetraspores, did not all comport themselves in the same manner. Some of them produced the ordinary four spores, but in the interior of the others globular cells arose provided with a beak, from which there came out colourless corpuscles, wonderfully like the antherozoids of the Florideæ. The resemblance of these bodies to species of Olpidium did not escape Dr. Wright, but struck by their constant presence on the specimens which he examined, by the regularity with which they appeared on determined points of the involucre, he thought they might be regarded as the antheridia of *Griffithsia setacea*, and here he has overlooked the fact that true antheridia, of the ordinary type in the Florideæ, had long since been described and figured in this very species by Thuret (*Ann. des Sc. Nat.* 3 ser. Bot. Tom. 16). On this occasion Dr. Wright, however, records an observation as new as interesting, viz., that he has seen the corpuscles as they left these wrongly imagined antheridia perform movements after the manner of amœbæ.

In the second of the two memoirs, having for its title "On the Formation of the so-called 'Siphons,' and on the Development of the Tetraspores in Polysiphonia," the author describes with much care the method of the formation of the frond in *Polysiphonia urceolata*, and very exactly proves the relationship existing between the "tube central" and the "siphons," and between the siphons themselves. For a great part he therein only confirms the results of those preceding him in such investigations, for the history of the development of the frond in Polysiphonia has been almost exhausted by the works of Naegeli, Kny, and Magnus. I am almost afraid that an analysis of these minute details would inspire the reader with that horror which, according to Naegeli, such morphological researches bring with them to the systematic botanists, but I cannot bring myself to omit extracting the following passage, in which some curious vital phenomena are incidentally described by Dr. Wright, as he found them to exist in the cells of Bryopsis.

"Under the influence of some local irritation, which must not be enough to injure the cell wall of the specimen under examination, the denser portion of the protoplasm will often be found to draw itself from the upper part of these cells. As it does so, the very conspicuous chlorophyll granules will be seen to be drawn together until they become pretty tightly packed. There is an apparent rounding off of the upper portion as it gets drawn down in the tube of the cell wall, and under a low power of the microscope this convex surface seems pretty sharply defined; but turn on a high quarter of an inch or an eighth of an inch objective, and a very remarkable phenomenon will present itself—for there will then be seen a mass of pseudopods not easily to be forgotten and difficult to describe under any other name; they stream away from below the apex of the cell wall, converging downwards until they are lost in the centre of the convex margin of the withdrawing mass of protoplasm. Here they are broad, while towards the apex of the cell they disappear through their very tenuity. Coursing down along these pseudopods, very minute granules can be, on careful focussing, detected; these are ultimately lost in the denser protoplasmic mass which engulphs them. This streaming goes on for a while, until all the protoplasm of a certain density is drawn into the lower mass; this then finally rounds itself off and forms an independent cell wall in front, which of course will be below the former growing point of the cell. There is apparently no plastic protoplasm remaining above this—no small disc even of homogeneous mucilage to be seen; all the viscid protoplasm seems to have gone to the rear, and it would appear as if the upper portion should now become sphacelated—perhaps disappear—and a new apical growth proceed from below it; but this is not so; there is life in the front still; it goes on growing as before, and in process of time it will be found to leave in its rear dense chlorophyll-bearing protoplasm, and so on through the several layers until the *punctum* itself is, as before, reached."

OUR ASTRONOMICAL COLUMN

BIELA'S COMET.—As bearing upon the possible return of Biela's comet during the latter part of the present year, it will not be out of place if we here summarise the results of an investigation made by Prof. Oppolzer in 1873, on the possible connection of the comet discovered by Mr. Pogson at Madras on December 2 previous, with Biela's comet and the great meteoric shower of November 27, 1872. It will be remembered that the comet in question was found in consequence of a telegram sent by Prof. Klinkerfues to Madras immediately after the meteoric display, to the effect that Biela's comet had "touched the earth" on the evening of November 27, and urging Mr. Pogson to search for it near the star θ Centauri. From the Madras observations on the nights of December 2 and 3 (the only occasions on which the weather was favourable), as they were first approximately reduced, Oppolzer derived the following data:—

1872, December 3·0 M.T. at Berlin.

Comet's geocentric longitude (λ)	... ...	223 15′·6
,, ,, latitude (β)	... ...	− 20 10·0

And the unit of time being a mean solar day,

$$\frac{d\lambda}{dt} = + 187'\cdot 0, \ \frac{d\beta}{dt} = + 46'\cdot 3.$$

At a subsequent time Mr. Pogson published more accurate positions of the comet than those at first communicated, which would give the following similar data, differing, it will be seen, in no material degree from those adopted by Oppolzer:—

1873, December 3·0 M.T. at Greenwich.

$$\lambda \ldots 223^\circ\ 21'\cdot 1 \quad \beta \ldots -20^\circ\ 8'\cdot 6 \quad \frac{d\lambda}{dt} \ldots + 189'\cdot 9 \quad \frac{d\beta}{dt} \ldots + 46'\cdot 4$$

It had soon been found, as might have been expected, that no satisfactory conclusion could be arrived at by comparison of Michez's elements of Biela's comet with

the observations, proportionally small variations in the elements producing greatly magnified effects upon the geocentric place and geocentric motion, in consequence of the close proximity of the comet.

Oppolzer describes his method of calculation in No. 1,938 of the *Astronomische Nachrichten*, to which we must refer the reader, as an outline of it would unnecessarily extend this note. He makes three assumptions as to the distance of the comet from the earth and deduces three orbits for comparison with the orbit of Biela's comet, as follow :—

	(A)	(B)	(C)	Orbit of Biela.
Distance assumed ...	0·04	0·08	0·12	—
	° ′	° ′	° ′	° ′
Mean anomaly	− 4 54·4	− 5 6·8	− 5 4·8	—
Long. of perihelion ...	128 48	141 9	151 50	109 45
,, ascending node	247 38	244 34	242 12	245 50
Inclination	9 14	10 28	11 46	12 22
Angle of excentricity..	51 36	54 17	56 49	48 48

It must be added that Oppolzer pre-supposes the comet moving in an orbit with same semi-axis major as that of Biela, the corresponding mean daily motion being 530″·1; hence with the above mean anomalies on December 3·0, the dates of perihelion passage on the three hypotheses would be respectively January 5·3, January 6·7, and January 6·5.

The similarity of these systems of elements is striking; only in the longitude of perihelion are there comparatively large differences, which Oppolzer observes, may not appear so noteworthy when it is remembered that Michez's elements do not include the effect of perturbations from 1866 to 1872, nor those which might just have resulted from the presumed exceedingly close approach of the comet to the earth on the night of the meteoric shower. The great difference of nearly three months in the perihelion passage, however, he regarded as against the identity of the object with Biela's comet, though from the anomalies which the disintegration of the comet might have occasioned, this circumstance might not really possess all its apparent signification. His general conclusions may be stated thus :—It may be asserted with confidence that assuming the distance of Pogson's comet from the earth December 3·0 to have been within the limits 0·04 and 0·12 of the earth's mean distance from the sun, we are led to elements which show a remarkable resemblance to those of Biela's comet, as well as with the course of the great shower of meteors on November 27, 1872. When the distance is much increased we find materially different elements, and the greater distance cannot be regarded as improbable; in this, Oppolzer remarks, lies in his opinion the weakest point of the argument, and only by observations at a future time can a certain conclusion be attained. Nevertheless he considers the striking coincidences following on arbitrary assumptions, taken together, militate strongly in favour of the approximate correctness of his assigned distance. Thus there seems to be under the above suppositions as to the comet's distance, a most remarkable connection with the meteor-shower of November 27. If, as a rough approximation, it is assumed that the comet at 8 P.M. on that day touched the earth, and further, that the differential daily variation of the distance within the $5\frac{6}{8}$ days was equable, an hypothesis, which in the case of a contact, will not differ much from the truth, there will be deduced from the three values, for the distance of the comet on December 3, respectively 0·061, 0·071, and 0·080; comparing these values with those assumed, it is seen at once that an agreement is established with the final value, when the distance = 0·07 nearly. This result Oppolzer urges as highly deserving of note, and in his opinion almost demonstrates the connection of the swarm of meteors with the comet. On the supposition that the true values of the elements must be sought between the systems (A) and (B), considering further that the earth on November 7·3 was in 65°·9, heliocentric longitude, and that the comet if it gave occasion to the meteor-shower must have been situate near its descending node, so the longitude of the node by this criterion would be 245°·9, a value which also falls between the limits (A) and (B).

Further, if the distance of the comet from the earth is calculated from the above elements for the time of the meteor-shower, the following series is formed :—

A		B		C
0·024	... ...	0·009	... ...	0·053

and it is seen that the assumption of 0·07 for the distance on December 3, leads to a very close approximation of the comet to the earth at the time of the shower. Calculating now the comet's radius-vector for November 27·3, the three systems give logarithmically—

A		B		C
0·0042	... ...	9·9950	... ...	9·9908

while the log. distance of the earth is 9·9940. Consequently with elements A and B the comet is a little outside the earth's orbit, and with elements C it would occupy a position within it. At the first glance it will appear probable that necessarily the last relation must have place, or the comet would certainly have been detected ere it reached its least distance from our globe. On the one side, from the uncertainty of the data for calculation, the results may be considerably in error, on the other there may be some probability that the comet was visible in the southern hemisphere, and we might have received intimation that a comet of great brightness and with rapid motion was there recognised. Calculating from the three systems of elements the geocentric place, there result—

	A		B		C
λ	67°	... ...	110°	... ...	180°
β	+11	... ...	− 75	... ...	− 25

so that, in fact, with the system B, which appears to approach nearest the truth, the circumstances of visibility for the southern hemisphere would be favourable.

Weighing all these circumstances, Oppolzer thought it must be granted that Pogson's comet stands with high probability in intimate relation with the meteor-shower of November 27, and that it is possible the observed object was one of the heads of Biela. That the second head was not found, is not decisive against this, since the same, on account of close proximity to the earth, might have been situate in an entirely different quarter of the heavens, and besides, from its greater relative distance, might have been considerably fainter, so as easily to escape detection. Thus, at the time of writing his paper on the subject, Oppolzer was of opinion that the connection of Biela's comet with Pogson's object and the meteor-shower was by no means to be regarded as improbable.

GEOGRAPHICAL NOTES

THE *Golos* publishes a telegram, dated the 13th of May, from the celebrated Central Asian traveller, M. Prjevalsky, formerly a colonel in the Russian army. At that time he was on the river Buluguna. He had marched 600 versts from Saisan along the river Urumtsu, and would immediately set out for Chemi through the southern Altai mountains. All the members of his expedition were in good health.

THE Alexandria correspondent of the *Daily News* sends some details of Major Serpa Pinto's recent journey across Africa from Benguela to Durban. He tells us little that has not been already made known, and we shall look with eagerness for Pinto's promised work. Science has evidently had considerable attentiont rom Major Pinto during his journey. He has brought home a collection of 1,800 plants and "a superb collection of birds and insects." Astronomical and meteorological observations have been taken along the route, and several volumes of notes made, with maps. The Coandó, which flows into the Zambesi,

is stated to have a length of 600 miles. It says much for the enthusiasm, if not for the knowledge, of the *Daily News* correspondent that he places Major Pinto in the "first rank of African explorers."

THE International African Association have received letters from MM. Cambier and Dutrieux down to March 16. They state their intention of remaining at Tabora till the end of the *masika*, or rainy season, which commonly ceases at the beginning of May. M. Cambier says that he has established friendly relations with the Arabs, and that he has ample resources for the next year without further supplies being sent. He also advises having forwarded an entomological collection made by Dr. Dutrieux. Though intelligence respecting this unfortunate expedition is remarkably vague, it may be hoped that we shall before long hear of their having done some real work, as they are now well advanced into the interior, have ample supplies, and the proper travelling season before them. The Association's second expedition will probably not be long before they start for the interior, as MM. Popelin and Van den Heuvel were to arrive on May 29 at Zanzibar, whither they have been preceded by M. Dutalis, who has already been engaged in a preliminary examination of the River Wami.

M. DE VILLIERS, the new Governor-General of French Cochin China, was Director of the Interior in Algiers under General Chanzy. He is the author of a dictionary of all the Algerian tribes and sub-divisions of tribes. This valuable work was published some years ago at the expense of the French Government.

THE current number of *Les Missions Catholiques* contains an account by Père Schmitt of a journey to Loango, in Western Africa.

THE new number of the *Annales de l'Extrême Orient* contains the first instalment of Dr. J. Harmand's "Notes de Voyage en Indo-Chine," illustrated by a map and copies of Khmer inscriptions. This is followed by part of a paper on New Guinea, in which is embodied much information respecting the Karons, the Kebars, and the Amberbaks. There are also some remarks by R. Friederich on the archæology and iconography of Java.

THE ERUPTION OF ETNA

ON the night of Sunday, May 25, loud bellowings were heard by the dwellers on the northern slopes of Etna. Towards the morning of the 26th these increased, and about midday a dense cloud of smoke was seen to issue from the side of the mountain below the great crater, apparently half way between Randazzo and Linguaglossa. This cloud increased, and on the 27th the mountain was rendered invisible, and an effect like that of an eclipse resulted. A rain of fine black ash, "like powdered emery," fell for miles around, and was so thick that Capo di Schiso could not be seen from Taormina, a distance of two miles. This black rain continued all day, accompanied by thundering noises from the mountain. No exact information could be procured concerning the position of the centre of disturbance, because no one could approach the new craters. During the night of the 27th the ashes continued to fall, and "huge fires could be seen looming through the black clouds"—no doubt the reflection of the molten lava on the smoke above it. It was reported in Piedemonte, a village on the north-

east flanks of Etna, that three craters about a mile apart had opened at the points of a triangle, about six miles above Passo Pisciaro, a posting station nearly midway between Randazzo and Linguaglossa. Lava was said to be flowing in a valley to the north of the Val del Bove. On the 28th a great stream of lava was seen from Taormina to be descending the mountain in the direction of Randazzo, "while from the new craters great balls of fire were thrown high in the air, and burst into showers of fire like gigantic rockets, accompanied by thundering explosions." On May 29 the lava was still flowing, but the shower of ash was diminished. The facts, as above stated, were witnessed by an Englishman living in Taormina, 800 feet above the sea, at the north-eastern termination of the flanks of Etna, about fifteen geographical miles from the new craters.

Daily bulletins in the newspapers have given us the history of the eruption since May 29. It is to be regretted that these have not been more concordant. Many times has the lava stream reached the bed of the river Alcantara, according to the telegrams, and often the next day has it been a kilometre distance. A telegram from Rome dated

June 3, and published in the *Times* for June 4, asserted that "the lava has still half a metre to run before reaching the Alcantara." The previous telegram asserted that the lava had run eleven kilometres from the craters, had rolled into the Alcantara, and had obliterated the Commune of Mojo; while the telegram of the following day made the stream 350 yards from the Alcantara. The fact is, that part of Etna is not thickly populated; distances are often guessed at; the new craters are not easily reached; and the shower of ashes prevented accurate observation, hence the discrepancies. But by a careful comparison of the telegrams, with the *Dettagli sull' eruzione dell' Etna*, issued by the Prefect of Catania at frequent intervals, the broadside sheets entitled *Guasti dell' eruzione dell' Etna*, and the letter written, on May 29, from Taormina, to the *Times*:—by comparing these with the fine map (scale = 1·266 inch to the mile) of the Italian Stato Maggiore, some of the discrepancies disappear, and a just estimate may be formed of the position of the new craters.

All accounts agree in placing the new craters near Monte Nero, but unfortunately there are two minor cones near together which bear the name of Monte Nero. We are helped out of this difficulty, however by the statement that the new craters are 1,900 metres (6,232 feet) above the level of the sea, that the higher of the two Monte Neros is far above this level, while the lower of the two has a little to the west of it a space marked by contours 1,900 metres. Here, accordingly, we shall place the new craters without hesitation.

The great crater, Randazzo, and Linguaglossa, form the three points of a nearly equilateral triangle, within which at present the eruption is completely confined. Linguaglossa is 12 miles from Randazzo, and 11 from the great crater, while Randazzo is only 10 miles from the crater. The new craters are 5 miles from the great crater, 7¼ from Randazzo, 7 from Linguaglossa, 7 from Mojo, 6½ from the River Alcantara, and 5 from Passa Pisciaro.

The lava has devastated the wood of Collebasso, and has crossed the main road at Passo Pisciaro, destroying the bridge there. Several vineyards have been destroyed, and if the bed of the Alcantara is invaded, the water supply will be cut off from a large tract of fertile land. The lava stream at Passo Pisciaro is about half a mile broad and 100 feet in depth. On May 30 it flowed at a rate of one metre per minute.

The last bulletin received to-day (June 6) from Catania dated June 1, 10 A.M., ends as follows:—"L'eruzione continua al solito. La lava verso il fiume dilatasi sempre, e scende insensibilmente. Stanotte un nuovo braccio investi la vigna di Salvatore Cimino, che quasi distrusse, producendo un danno di circa trentamila lire. La casina prospiciente sullo stradale versa in imminento pericolo." Signor Silvestri of Catania, together with two Germans, have penetrated as near as possible to the new craters. Silvestri, together with Prof. Blaserna of Rome, and Prof. Gemellaro of Padua, have been appointed to report on the eruption, in the interests of vulcanology. It was asserted in the telegram of June 6 from Messina that the stream of lava is only 100 metres from the Alcantara, and that it is advancing at a rate of fifteen metres per hour. Loud rumblings and dense smoke proceed from the new craters.

During the last few days the telegrams have stated that the eruption is diminishing, and that although the lava has slowly progressed, it has not yet reached the Alcantara. Some curious errors have been propagated in the newspapers. Thus the *Times* correspondent in Naples, writing under the date of June 2 (published June 10), asserts that "the side on the north-west is rent in two, and the fiery mass is ejected to the height of 1,900 metres, or considerably more than a mile." The real facts are that the new craters stand at an elevation of 1,900 metres above the sea; while a fissure which does not extend over even one-half the north-west side of the mountain, has been formed near Monte Nero. It has been asserted that saline mud has recently been ejected; also that the craters emitted on June 2, 450 cubic metres of lava per minute; also that the principal lava stream has a front of 800 metres, and that it has flowed for six or seven miles, But in regard to any exact statements, it will be preferable to wait for the report of Professors Blaserna, Gemellaro, and Silvestri; or at least for the very detailed account of the eruption, which is sure to appear in the next number of Prof. de Rossi's *Bolletino del Vulcanismo Italiano.* G. F. RODWELL

NOTES

WE understand that by permission of the Statistical Committee of the India Office, the new tide-predicter, which has been constructed for the Survey Department by Mr. E. Roberts (*Nautical Almanac* Office), will be exhibited at the closing meeting of the Royal Society on the 19th inst. The instrument, although not yet out of the makers' hands, is sufficiently complete to show its entire working; in fact, the tide-curves for the year 1880 for Bombay and Kurrachee, have been already run off, and the results are now being tabulated for printing. Specimen tide-curves of the Southern Indian, Pacific, and North Atlantic Oceans, the English Channel, and the Mediterranean, will also be exhibited to show the universality of the system of prediction by the instrument.

AMONG those on whom the honorary degree of LL.D. was conferred in the Senate House at Cambridge on Tuesday were Mr. Justice Grove, Dr. W. Spottiswoode, Prof. Henry J. S. Smith, Prof. T. H. Huxley, and Mr. H. C. Sorby.

PROF. HUXLEY has been elected a corresponding member of the Paris Academy of Sciences, in the section of Anatomy and Zoology, in succession to the late Prof. von Baer; and M. Schiaparelli in the Section of Astronomy, in place of the late M. Tisserand.

THE death is announced, on the 9th inst., of Dr. Moore, who for more than forty years has filled the office of Curator of the Botantic Gardens, Glasnevin, Dublin. He was a native of Dundee, and commenced the study of botany under the late Dr. Mackey, Curator of the College Botanical Gardens, whose place his eldest son, Dr. F. W. Moore, now fills. He was for some time employed on the geological survey of Ireland before he was appointed Curator of the Royal Dublin Society's Gardens at Glasnevin. He pursued the study of botany with great ardour, not only at home, but in various parts of the Continent. Among his works were "Notices of British Grasses," "Irish Hepaticæ," and "Irish Mosses."

IT is proposed immediately to establish a zoological station on the Aberdeen coast, in connection with the natural history laboratory of the University, similar to those already instituted for the Universities of Paris, Vienna, and Leyden. The objects of such a station are:—1. To supply the laboratory with fresh animals for purposes of teaching and research. 2. To enable students to become practically acquainted with natural history, and to afford them opportunities of advanced study and independent research, during the vacations. 3. To afford means for the exhaustive study of the marine fauna. For the establishment of such a station on the smallest possible scale it is necessary to have—(1) A movable shed or house with suitable fittings; (2) a large fishing boat and a small two-oared boat; (3) nets and dredges; (4) aquaria glassware and miscellaneous apparatus; (5) the services of a fisherman and a boy for part of the year. For the purchase of boats and apparatus a sum of 250*l*. is required,

and for wages, &c., at least 75*l.* annually. Lord Roseberry has given a donation of 50*l.*, and other subscriptions raise the total sum already obtained to 180*l.* It is not creditable to this wealthy country that it possesses no zoological station, and we trust our readers will do what they can to assist in raising the moderate sum required. Subscriptions may be sent to Mr. G. J. Romanes, 18, Cornwall Terrace, Regent's Park, N.W.

A NEW work is announced by Prof. Boyd Dawkins, on "Early Man in Britain and His Place in the Tertiary Period." In this the results of geological and archæological research, so far as they relate to the history of man in this country, will be placed before the reader in a connected narrative. Man will be treated as the central figure in the tertiary period, and the various changes in geography, climate, and living forms which preceded his arrival in Britain, will be examined, as well as those changes in his environment which took place after he appeared in Europe. His antiquity, his relation to the glacial period, and to existing peoples, and his manner of life, will be discussed, as well as the distribution of the Iberic and Celtic races, their manners and customs, their progress in civilisation, and the extent to which they were influenced by the civilised nations of the Mediterranean. It is the principal object of this work to give a picture of man isolated in Britain, from his first arrival down to the Roman invasion. It will be largely illustrated with maps and engravings. The work will be published by Messrs. Macmillan and Co.

MR. RUDLER has succeeded to the place of the late Trenham Reeks, in the Geological Museum, Jermyn Street.

IN an appreciative article on Sir Henry Bessemer, *à propos* of his knighthood, the *Times* gives some striking statistics to show the vast advances made in the production of steel since the adoption of the Bessemer process:—"Prior to this invention the entire production of cast steel in Great Britain was only about 50,000 tons annually, and its average price, which ranged from 50*l.* to 60*l.* per ton, was prohibitory of its use for many of the purposes to which it is now universally applied. In the year 1877, notwithstanding the depression of trade, the Bessemer steel produced in Great Britain alone amounted to 750,600 tons, or fifteen times the total of the former method of manufacture; while the selling price averaged only 10*l.* per ton, and the coal consumed in producing it was less by 3,500,000 tons than would have been required in order to make the same quantity of steel by the old or Sheffield process. The total reduction of cost is equal to about 30,000,000*l.* sterling upon the quantity manufactured in England during the year; and in this way steel has been rendered available for a vast number of purposes in which its qualities are of the greatest possible value, but from which its high price formerly excluded it. During the same year the Bessemer steel manufactured in the five other countries in which the business is chiefly conducted—namely, the United States, Belgium, Germany, France, and Sweden—raised the total output to 1,874,278 tons, with a net selling value of about 20,000,000*l.* sterling. The works in which these operations were carried on were eighty-four in number, and represent a capital of more than three millions. According to the calculations of Mr. Price Williams, who has made the endurance of rails a matter of careful study, the substitution of Bessemer steel for iron for this purpose alone will produce a saving of expenditure during the life of one set of steel rails on all the existing lines in Great Britain of a sum of more than one hundred and seventy millions sterling. It may safely be said that there is no other instance in history of an analogous impetus to manufacture, or of an analogous economy, being the result of the brain-work of a single individual; still less is there an instance of such results being realised while the inventor was living to enjoy the fruits of his labours, and able to work in fresh directions to increase the benefits which he had already conferred upon his country and upon mankind."

THE enterprising Birmingham Natural History and Microscopical Society have again arranged a marine excursion, this time to Falmouth, during next month, on a somewhat similar principle to those to Arran, which proved so successful in the last two years. Facilities will be afforded for dredging excursions and for land excursions to investigate the botany and highly interesting geology of the district. The botany of the district is very peculiar and interesting, and the geology is unique in the British Islands, Kynance Cove and the Lizard being within easy reach of day excursions from Falmouth. During the summer season a most interesting series of observations may be made on the microscopic larval forms of marine life (hydroids, echinoderms, annelids, &c.), which abound in the sea, and may at this time readily be taken by the tow net. A small steamer will be chartered, which will economise time and add to personal comfort. The marine fauna of the Cornish coast is exceedingly rich and varied. The time for the excursion will be from the 5th to the 14th or 21st of July.

PROF. VIRCHOW has returned to Berlin from Asia Minor, where, as our readers are aware, he had taken part in Dr. Schliemann's excavations. The learned professor was received with great honours at Athens. The Medical Faculty of the High School of that city presented him with the honorary doctor's diploma, and the Medical Society of Athens elected him an honorary member.

IN digging a channel in the neighbourhood of Lake Neuchâtel, a lacustrine canoe, very nearly seven metres long, has been found. It has been placed in the Cantonal Museum.

IN addition to the list of quite recent earthquakes we gave last week, we now have reports of two more. At Aachen (Aix la Chapelle) several shocks were felt on May 26, soon after 8 P.M., which seemed to proceed in the direction from west to east; and at Idstein (in the Prussian province of Nassau) a violent shock occurred on May 27, about 1 A.M.

M. DE LESSEPS has accepted the chairmanship of a committee for arranging the commemoration of the eighteenth centenary of the great eruption of Vesuvius in 79, when Pliny lost his life, and Pompeii and Herculaneum were destroyed. According to the most trustworthy records it was on the 23rd of August that this unexpected event took place.

M. CLAMOND, the inventor of a thermo-electric pile, has succeeded in producing a current strong enough to work a Serrin regulator with tolerable success. The expense is only 7 kilogrammes of coals per hour, and the appearance of the battery reminds one of an ordinary furnace.

THE Paris Academy of Meteorological Ascents has inaugurated the series of its aërial excursions. The first took place at St. Mandes and the second at Arcueil on the occasion of the opening of the École Laplace. The ascensionists propose to take photographs from the car in order to ascertain the position of the balloons and make a verification of the laws of barometric height. The original idea of this difficult operation may be attributed to Leverrier. Each of these ascents will be followed by the publication of diagrams and scientific results obtained. They are prefaced by a lecture, given by a member of the association, on the practice of aëronautics.

FROM June 7 up to the end of the month the exhibition of Beaux Arts at the Paris Palais de l'Industrie will be lighted every night by electricity. The motive power is supplied by 262 Jablochkoff electric lights. 120 have been distributed in the

gardens where statues are exhibited; 142 in the saloons where pictures are suspended on the walls. The 120 candles are surrounded by opaline globes, which diminish the total effect, but the general illumination is satisfactory. The other 142 have been placed in translucent glass spheres, which leaves the light its original force. The appearance of the pictures is splendid and the general impression is exceedingly favourable. It is supposed that the garden could well be arranged shortly according to the same system, and the illumination will be unrivalled in brilliancy. The partial extinctions are very few and generally very easily repaired. The motive force is supplied by four steam-engines placed in a shed at a distance, and is estimated at 300-horse power (seventy-five for each motor). The consumption of coal and other expenses are very small in comparison with the receipts which were more than 200*l.* for the first evening. It is divided in two equal parts, one for the Government and the other for the Jablochkoff Company. But the speculation cannot be said to be a paying one owing to the expenses of installation. The length of insulated wire is about 42,000 yards at a shilling each, and the other expenses in proportion. But it is supposed that the scientific exhibition will inherit the bargain and the electric fixtures, which are said to be worth 20,000*l.* will be in constant use up to the Month of November.

FROM Friedländer and Son, of Berlin, we have received two very full Catalogues of works in Geology and Geognosy, which we commend to all interested in these subjects.

IN reference to a statement in the *Globe* that the prediction of an earthquake to happen on or about May 21 was falsified, a correspondent, Mr. Frank Barnard, writes that on that day he felt the movement of an earthquake at Hastings, at 12 noon. He describes it as a quivering of the ground, slight, but too palpable to pass unheeded, communicating a quiver to his whole frame such as he never felt before. He forwards us a cutting from his sketch-book, on which he pencilled at the time a record of the occurrence.

IN reference to Mr. Hosie's article in last week's NATURE, on Chinese Observations of Sun-Spots, a correspondent writes that Mr. Sayce, in his "Babylonian Literature," shows that more than 4,000 years ago it was recorded in the library of Nineveh that the sun was spotted on the first day of the Chaldean year, "from which," says a *Times* reviewer, "we may infer the presence of an unusually large spot." We may, our correspondent thinks, infer more—the presence of spots.

MR. R. ETHERIDGE has written to the *Times* on a boring made by the New River Company at Ware in Herts, in which it was found that the Gault at a depth of 800 feet rests upon the Upper Silurian rocks (the Wenlock Shale), richly fossiliferous, dipping at an angle of 40 deg., but to what point of the compass is not at present known. The *Geological Magazine* for June reprints the letter and appends a list of the fossils found in the cores of the Wenlock.

WHEN King Victor Emmanuel took possession of Rome he left the Roman Observatory in the hands of the late Father Secchi, out of respect for his exceptional merits. When Father Secchi died, the Pope appointed his successor, who took possession of the establishment and refused to leave the place. He has been expelled, however, *manu militari*.

THE Roman Alpine Club has decided to send an excursion to Etna, which will leave Rome on July 1. Intending excursionists are directed to address the Secretary of the Roman section of the Italian Alpine Club before the 15th instant, as preparations are required for the comfort and safety of the excursionists. We believe that any one, irrespective of nationality, can join the excursion. The travelling expenses from Rome to Catania will be diminished by one-half, owing to the liberality of railway and steamer companies. The duration of the excursion will be at least seven days.

WE have received several numbers of the *Naturalist*, the journal of the Yorkshire Naturalists' Union, from which we see that the many societies composing that union are as active as ever. A most interesting series of excursions has been arranged for the summer.

M. E. MOREL, who has been Belgian Consul at Shanghai for many years, has informed the *North China Herald* that his Government, with the view of bringing the manufacturers of Belgium into greater prominence, contemplate the establishment at that port of a permanent museum in which specimens of all descriptions of Belgian manufactures and produce will be exhibited. It is believed that about 1,000*l.* per annum will be expended on this object.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus erythræus*) from India, presented by Mr. J. Beech; a Golden Eagle (*Aquila chrysaëtos*) from the Western Hebrides, presented by the Earl of Dunmore, F.Z.S.; a Red and Yellow Macaw (*Ara chloroptera*) from South America, presented by Miss C. Cattlin; two Common Kingfishers (*Alcedo ispida*), British Isles, presented by Mr. W. W. Cobb; a Common seal (*Phoca vitulina*), British Isles; three Javan Peafowls (*Pavo spicifer*) from Burmah, deposited; three Maned Geese (*Bernicla jubata*) from Australia, purchased; an Eland (*Oreas canna*), a Canadian Beaver (*Castor canadensis*), a Great Kangaroo (*Macropus giganteus*), a Red Kangaroo (*Macropus rufus*), a Bennett's Wallaby (*Halmaturus bennetti*), born in the Gardens; four Amherst Pheasants (*Thaumalia amherstiæ*), three Egyptian Geese (*Chenalopex ægyptiaca*), bred in the Gardens.

SCHLIEMANN'S TROJAN EXCAVATIONS

THE *Times* of Tuesday contains several letters from Dr. Schliemann, describing the researches he has been recently making in the Trojan country in company with Dr. Virchow of Berlin, and M. Burnouf, of Athens. They endeavoured to ascertain the geological character of the plain of Troy, by sinking shafts in different parts between Mount Hissarlik and the Hellespont. Dr. Schliemann states:—"We obtained everywhere the same result—viz., below the clay soil a thick layer of coarse or fine river sand, and below it the very compact dark-brown clay of the plain. But the most important result was obtained by the shaft we sunk in the Stomalimne, mentioned by Strabo, which is an easily recognisable swamp, situate between the mouths of the rivers; it slopes abruptly from the plastic clay of the plain to a field of sand which is nearly on a level with the sea. Excavating there, we found below the layer of sand, which is hardly an inch thick, a layer of plastic clay, about 16 inches thick, which is perfectly the same as in the plain, and below it a dark-blue sand containing putrified vegetable matter, which can leave no doubt that here existed a swamp. The upper part of this layer of blue sand is exactly on a level with the sea and with the adjoining inlet, the water of which is brackish and has no current. Having dug in this blue sand a large hole two feet deep, we saw the water filtering from all sides through the sand and soon filling the hole completely, and thus the water's surface was on a level with both inlet and sea; but this water was sweet and drinkable. In no one of our shafts sunk elsewhere did we discover the slightest trace of the sea having ever sojourned there; everywhere we found only the produce of sweet water. Thus it is evident that the soil of the plain of Troy has been produced by sweet water, and that this deposit is anterior to the existence of both the Scamander and the Simois, the more so as the modifications produced by these rivers are but very slight." Therefore he maintains the theory that at the time of the Trojan war the sea formed a deep gulf in the Plain of Troy, that the later Ilium (Hissarlik) was too near the Hellespont, and no space left for the great deeds of the "Iliad"; that consequently the two cities

could not possibly be identical—is now exploded and can never be revived again. Both Professor Virchow and Mr. Burnouf have accepted Dr. Schliemann's theory that the immense bed of the small and insignificant rivulet Kalifatli-Asmak, which has no running water except during the inundations in winter—that this river-bed, which has in many places a breadth of from 660 ft. to 825 ft. —is identical with the ancient bed of the Scamander.

Dr. Schliemann then describes the results of his excavations on the gigantic tumuli called Udjek-Tepé and Besika-Tepé. He now inclines more and more to the conviction that these and other immense Trojan tumuli were no real tombs, but mere memorials erected in commemoration of some great event. "They certainly existed at the time of Homer, who mentions four of them (those of Batieia, Æsyetes, Ilus, and Achilles) as real tombs, no doubt because, in his time, similar conical tumuli were erected at Sardis and elsewhere on the Asiatic coast over the ashes of great men."

In continuing his excavations at Troy, Dr. Schliemann found two other treasures of Trojan gold jewellery, and Ilium, he states, appears now exhausted. Dr. Virchow and M. Burnouf are astonished at the monstrous quantity of bricks, which solely occur in the burnt city. The three explorers are convinced that these bricks must have been slightly burnt in an oven before being used for building.

Mr. Sayce, in a letter in yesterday's *Times*, states that the markings on a fragment of pottery, a *fac-simile* of which was sent him by Dr. Schliemann, are rude attempts to imitate cuneiform characters on the part of a potter who was unacquainted with the meaning of the latter. "As is well known, the specimens of Phœnician art found in the Mediterranean frequently bear rude representations of Egyptian hieroglyphics figured for the sake of ornament, and grouped in such a way as to show that the artist had not the faintest idea of their signification. If my view of the markings on the piece of pottery discovered by Dr. Schliemann is correct, it becomes certain that some kind of prehistoric intercourse was carried on between the Troad and the populations who employed the cuneiform system of writing, and since the remains found at Hissarlik show little or no trace of Assyrian or Phœnician influence, the intercourse must be assigned to the older Babylonian period. Five years ago I suggested that some of the designs on the terra-cotta disks from Hissarlik might be rude imitations of designs on archaic Babylonian cylinders. I may add that Mr. Newton, to whom I showed the *fac-simile* sent me by Dr. Schliemann, thought my view of it very possibly right."

In connection with the above the *Times* states that a recent number of the *Norddeutsche Zeitung* stated that the Chinese Ambassador at Berlin, Li Fangpao, well known in his own country as a great scholar, has lately read as Chinese the inscription on a vase found by Dr. Schliemann in the lowest stratum of his excavations at Hissarlik, and figured on p. 50 of the introduction to his "Troy and Its Remains." Li Fangpao is quite confident that the unknown characters, which recur again and again on the Trojan antiquities, especially on the terra-cotta whorls, are those of his native tongue, and gives as the purport of the inscription, that about B.C. 1200, three pieces of linen gauze were packed in the vase for inspection.

With reference to this Mr. Sayce states that the authority of the Chinese ambassador, high as it is, will never persuade any one acquainted with the characters of the Cypriote syllabary that the characters found on some of the objects from Hissarlik are Chinese. As was stated in a *Times* leader, they belong, Mr. Sayce repeats, to the curious syllabary which seems to have been used on the coasts of Asia Minor and in the islands of the Ægean before the introduction of the simpler Phœnician alphabet, and which continued to be employed in conservative Cyprus down to a late date.

ON THE ORIGIN OF THE SOLAR PROTUBERANCES

WE take the following from a communication made by Herr Spörer to the Berlin Academy on November 7:—

"Simultaneously with the minimum of sun-spots the protuberances have been also insignificant hitherto, but since the middle of this year (1878), while the spot minimum continues to last even far beyond expectation, important protuberances have yet appeared, and among them some from which important deductions may be drawn with tolerable certainty.

"According to my observations of the year 1871 I had distinguished two classes of protuberances, viz., the ordinary hydrogen protuberances, and the flame-like protuberances which are remarkable on account of their intensity and pointed forms. In the latter ones, apart from the H lines and D_3, the magnesium lines may be easily recognised even with the smaller 5-inch telescope, which was then and is now at my disposal; other lines are less easily recognised. When Secchi agreed with me in this division of protuberances he chose the name of 'metallic' ones for the second kind, because the lines of metallic elements principally appear in them, apart from the H lines and D_3.

"No doubt we may suppose that many of the ordinary hydrogen protuberances originate through *storms* forcing up the hydrogen sea in gigantic *whirls* and *waves*, and I have also succeeded in finding examples confirming this, as the changes observed took place entirely after the manner corresponding to our waterspouts; this, however, does not exclude that many of the hydrogen protuberances originate through eruptions from the interior of the sun's body. We are still more inclined to look upon the flame-like protuberances as *eruption* products. I had considered also whether for the explanation of these, electricity might not be taken into account, particularly since then the quick shooting up and the quick change of the formations would not have to be explained merely by the motion of masses, and the over-great velocity would not be so surprising. Indeed, observed zigzag lines of communication between neighbouring flame-like protuberances had suggested the thought of *electric discharges*.

"The thought that bright protuberances do not start from the surface, nor yet from the hydrogen envelope, but rather that they are formed only at a certain height, therefore that perhaps at the low temperature existing at greater heights, *chemical combinations* take place, and that only by these the intense flaring up is produced—this thought may doubtless not be designated as a new one, but no forms of protuberances have been published yet which would decidedly favour this view."

Herr Spörer then quotes from numerous Italian publications a considerable number of protuberances which appeared *perfectly detached* from the surface, and says he could considerably augment these examples from his own observations. But the objection may be made to these cases that the formations described are only the remains of larger ones which previously had their origin at the sun's surface. This objection is perfectly justified since observations have proved often enough that brightly luminous protuberances became partly obscured, and particularly that the foot of a protuberance disappeared while the upper part remained visible.

It is necessary therefore to adduce such examples where the proof may be furnished with certainty that a luminous formation which is observed detached from the surface, did not originate *at* the sun's surface. Now Herr Spörer together with Herr Kempf has observed protuberances of this nature in July and August last year; he deferred their publication in the hope of being able to obtain more examples; this hope was annihilated for the present through the beginning of the unfavourable season, and hence the observations which had been made were made known. There were altogether three observations of this kind, which Herr Spörer describes and represents by illustrations; here we must confine ourselves to reproduce the one case which was the most favourable one to his theory, and which was observed on July 22 from 5h. 30m. until 6h. 50m.

The protuberance appeared in lat. 35°–40° south, and attained a height of 46″, or 34,000 kilometres. First of all it was seen in one point in the shape of an eruption, which, by the action of storms, was partly deviated to the left. In this direction an arc appeared, which expanded further to the left (possibly always in consequence of storms), until later on it touched the sun's surface, and thus spanned a dark segment. Intensely bright rays were remarkable about 5h. 47m. when they first appeared, and which proceeded from the highest part of the arc segment in a vertical direction, and quite detached from the solar surface. The direction of the rays did not permit the idea that they might have been torn off from the protuberance on the right by the action of storms perhaps, or otherwise. Then a larger mass was formed by these rays, whereupon extremely quick and varied changes took place, the exact observation of which was impossible, since the slit of the spectroscope could not be widened and therefore only a part of the protuberances could be observed at a time. At 6h. 12m. the complete arc was seen, the denser part over the middle had become a little looser, but glistening points were again present, standing perpendicular upon the arc; the formation had assumed larger dimensions at 6h.

23m. To the right a new ray had formed, which attained a much greater height than the other parts of the protuberance, viz., to 61", or 46,000 kilometres, and which lasted only for a short time.

It might perhaps be thought possible that the vertical rays over the middle of the segment and the larger protuberances originating there, had yet been in connection with the sun's surface, the dark segment having formed the foreground, so that dark and dense gases of this segment might have hidden the parts behind them from view. But then the segment ought to have appeared as a sun spot later on, if it had not happened to appear at the very extreme limb. On account of the enormous dimensions a spot of this kind could not have disappeared entirely until the following day, on July 23, therefore, at least some remains should have been observed really as a spot. But there were not any spots on the sun's disk neither on July 23 nor on the following days, except two small spots on the northern hemisphere on July 26. At the same time we might remark that in the high southern latitude of the protuberance so large a spot has never appeared before; this we know by experience.

The examples of July 24 and of August 9 are equally important, if indeed less grand in proportions. In both cases the protuberance, seen detached from the solar surface, could not be due to the action of storms, but, like the one described above, rather appeared to favour the hypothesis of the *origin* in higher regions.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Cambridge Museums and Lecture Rooms Syndicate have issued their thirteenth annual report, in which they give details of the progress made in the buildings in course of construction. They report that they have no hope that the necessary expenditure upon the various departments of the museums can again be brought within the limits of the existing allowance for their maintenance. Having regard to the present state of the University finances, they have directed a curtailment of expenditure in all directions. This economy, however, although unavoidable at present, will, if persisted in, lower the standard of scientific education in the University, for it will be impossible to maintain the departments in their present state of efficiency. They hope that at no distant date the University will be in a position to increase the fund to a sum sufficient for their proper maintenance on the enlarged scale rendered necessary by the erection of the new buildings and the increased number of students. Appended to the report are the reports of the various professors, the superintendent of the Museums of Zoology and Comparative Anatomy, the Strickland Curator, and the Trinity Prælector of Physiology on the conditions of their several departments.

A MEETING of the curators of the University of Edinburgh was held on Friday, the 6th inst., with reference to the vacancy in the Chair of Mathematics caused by the death of Prof. Kelland, and it was resolved to hold another meeting early next month as to the appointment of a successor. Meantime, it is requested that the applications of intending candidates, accompanied by any testimonials desired to be submitted, be forwarded by Saturday, July 5. The emoluments, which are derived from a fixed endowment and from class fees, amount to between 1,200*l*. and 1,500*l*. per annum. Any details desired can be obtained from the Secretary to the Senatus Academicus.

THE ninth Annual Report of the Wellington College Natural History Society has to record a good deal of satisfactory work done, as is evident, indeed, from the very full lists and reports appended in the various departments. We should like to see the recommendation adopted given to those Fellows who do not play cricket, that they should devote themselves in the afternoons to the observations of birds and insects. A very fair proportion of the members, however, seem to do work.

THE new university building of Marburg was inaugurated on May 29 in the presence of Dr. Falk, the German "Cultusminister."

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 15.—"On the Capillary Phenomena of Jets," by Lord Rayleigh.

In this paper are given the results of observations and their discussion on water issuing under varying pressure from orifices of various shapes.

Geological Society, May 28.—Henry Clifton Sorby, F.R.S., president, in the chair.—Edward Garlick was proposed as a Fellow of the Society.—The following communications were read:—On the endothiodont reptilia, with evidence of the species *Endothiodon uniseries*, Owen, by Prof. R. Owen, C.B., F.R.S. The author referred to the characters assigned by him to his *Endothiodon bathystoma*, which had the alveolar borders of both jaws toothless, perhaps covered with horn during life, as in the Chelonians; whilst within this border there were three series of teeth both in the palate and the mandible. He next described a new species, under the name of *Endothiodon uniseries*, founded upon the fore-half of a skull, having only a single row of teeth in the palate, a character which may prove to be of generic importance. The author finally discussed the relationships of this genus, which he regarded as belonging to the order Anomodontia, and as showing, like *Oudenodon*, traces of derivation from *Dicynodon* in the presence of caniniform processes in the upper jaw. The development of teeth interior to the alveolar margins in both jaws was to be regarded as a character of family value, and the author remarked upon the interest of the continuance of a common ichthyic and batrachial dental character in exceptional cases among the reptilia up to the establishment of the crocodilian type, above which, in the vertebrate series, calcified palatal teeth no longer appear.—Note (third) on *Eucamerotus*, Hulke, *Ornithopsis*, Seeley, = *Bothriospondylus magnus*, Owen, = *Chondrosteosaurus magnus*, Owen, by J. W. Hulke, F.R.S.—Description of the species of the ostracodous genus *Bairdia*, M'Coy, from the carboniferous strata of Great Britain, by Prof. T. Rupert Jones, F.R.S., and James W. Kirkby. The long persistence of the genus *Bairdia*, from the silurian period to the present day, and its essentially *marine* character, were first noticed; also the relatively rare occurrence of any species of *Leperditia*, *Beyrichia*, and *Kirkbya* (associates of *Bairdia* in carboniferous strata) in fresh-water or estuarine beds. *Carbonia*, on the other hand, was confined to the fresh or brackish waters in which the coal-measures were formed. The difficulty of defining the species of *Bairdia* from carapace-valves alone, without limbs and soft parts, and the possibility of several genera being grouped under this head, were mentioned. The species of *Bairdia* described and figured in this paper were, it is believed, all that have been found in the British carboniferous rocks, with the exception of M'Coy's *B. gracilis*. Two of Count Münster's Bavarian *Bairdiæ*, from Hof, have not yet occurred with us; neither have four of Dr. d'Eichwald's Russian carboniferous species, nor the Australian *B. affinis*, Morris. Including these, there are twenty-three known carboniferous species of *Bairdia*. Seven of these are recurrent in the overlying permian limestones, which have yielded twelve species of this genus. With six silurian forms, there are altogether thirty-four recorded palæozoic species of *Bairdia*.—Report on a collection of fossils from the Bowen River coal-field and the limestone of the Fanning River, North Queensland, by R. Etheridge, jun., F.G.S.—On a fossil *Squilla* from the London clay of Highgate, part of the Wetherell collection in the British Museum, by H. Woodward, F.R.S.—On *Necroscilla Wilsoni*, a supposed stomatopod crustacean from the middle coal-measures, Cossall, near Ilkeston, Derbyshire, by H. Woodward, F.R.S.—On the discovery of a fossil *Squilla* in the cretaceous deposits of Hâkel, in the Lebanon, by H. Woodward, F.R.S.—On the occurrence of a fossil king-crab (*Limulus*) in the cretaceous formation of the Lebanon, by H. Woodward, F.R.S.

Zoological Society, June 3.—Prof. W. H. Flower, LL.D., F.R.S., president, in the chair.—The Secretary exhibited and made remarks upon two volumes of original drawings of the birds of India, which had been deposited in the Society's Library by Brigadier-General A. C. McMaster. The volumes contained about 270 figures of the birds of India, most of which had been drawn by soldiers in General McMaster's house at Secunderabad.—Mr. Sclater exhibited and made remarks on a small collection of birds forwarded to him by Dr. A. Döring, of the University of Cordova, in the Argentine Republic.—Mr. W. Ottley gave a description of the blood-vessels of the neck and head of the ground hornbill.—Mr. Edward R. Alston read a paper on the specific identity of the British martens, in which he pointed out the distinguishing characters of *Martes sylvatica* and *M. foina*, and showed that the former species only is found in this country.—Messrs. Sclater and Salvin gave an account of the birds collected by the late Mr. T. K. Salmon in the State of Antioquia, United States of Columbia. Mr. Salmon's collections were stated to have been very extensive, having been the product of

some five or six years' assiduous collecting, and to have contained altogether about 3,500 specimens of birds, which were referable to 469 species.—Mr. G. French Angas gave an account of the land-shells collected by the late Dr. W. M. Gabb, in Costa Rica. The collection was stated to contain examples of forty-two species, of which ten or twelve were believed to be new to science.

Anthropological Institute, May 27.—Mr. E. Burnett Tylor, D.C.L., F.R.S., president, in the chair.—A paper by Mr. Hodder M. Westropp was read, entitled notes on fetichism, in which the views of Prof. Max Müller on the subject of fetichism as expressed in his late lectures on the development of religion were combated, and Mr. Westropp advanced an opposite theory of his own. Having stated all the points of difference between himself and Prof. Max Müller, the author explained his position thus:—that those who believe in a primordial fetichism must take it for granted that human beings passed through a rude and primitive phase when their minds were naturally and instinctively endowed with certain vague ideas of spirits and ghosts, which seem to be the spontaneous outgrowth of minds in a rude and primitive condition in all countries and in all ages. In the same way it must be taken for granted that all human minds have passed through a state of infancy.—A paper was also contributed by Mr. J. Matthew, of Little River, Victoria, on the Kabi dialect of Queensland. Although the Australian dialects are usually spoken of as agglutinative, the author considered that if it were possible for a language to be classed as isolated, although having the majority of its words composed of two syllables, such a language is Kabi.

Mineralogical Society of Great Britain and Ireland, June 3.—Prof. T. G. Bonney in the chair.—The election of fourteen Corresponding Members, eight Ordinary Members, and two Associates, was announced.—The following papers were read:—On abriachanite, a new Scottish mineral, by Prof. M. F. Heddle and Dr. W. H. Aitken.—On haughtonite, a new mica, by Prof. M. F. Heddle.—On brechite and xantholite from Scotland, by Prof. M. F. Heddle.—On christophite from St. Agnes, Cornwall, by J. H. Collins, F.G.S.—Minerals from Japan, by John Milne.—On some gold occurrences, by the Rev. J. Clifton Ward, F.G.S.—Additional note on penwithite, by J. H. Collins, F.G.S.—Measurements of angles of basaltic columns from the Giants' Causeway, by Professors Jellett and O'Reilly.

PARIS

Academy of Sciences, June 2.—M. Daubrée in the chair.—A telegram from the Emperor of Brazil stated that Tempel's comet had been seen on the 24th and 25th ult.—On the magnetic impenetrability of iron, by M. Jamin. The experiments prove that a given current through coils magnetises a bar much less when the latter is inclosed in a tube than when exterior to the tube (placed beside it); and the tube is more magnetised in the former case than in the latter. 6 mm. of concentric thickness of iron suffices to arrest almost completely the magnetic effect of an exterior spiral.—On the ultra-violet limit of the solar spectrum, by M. Cornu. Taking fine days, a collodion of constant composition, and a constant time of exposure, very comparable observations are had. The extent of the spectrum diminishes with the altitude of the sun, which tends to prove that the limitation is due to absorption by the atmosphere. The furthest limit obtained was at wave-length 293; this was only twice, on June 24 and August 18, 1878, about noon. M. Cornu discusses the causes of error, the conditions of extending the limit, and the variation of the limit with the height of the place of observation. The limit is pushed back one-millionth mm. in wave-length as you rise 663·3 m. (a small gain; becoming only 6 millionth mm. for 4,000 m. altitude, or about half the difference between winter and summer).—On alkaline amalgams, and on the nascent state, by M. Berthelot. A thermal study of the reducing action of these amalgams on organic compounds. They always liberate, in hydrogenising reactions, more heat than free hydrogen would, the respective excesses for amalgams of sodium and potassium being 32·8 and 27·5.—On stannpropyls and isostannpropyls, by MM. Cahours and Demarçay.—On the quantity of nitric acid contained in the water of the Nile before and after flood, by M. D'Abbadie. Having observed that thunderstorms accompanied most of the Ethiopian rains, he thought traces of the nitric acid formed would be found in the river at Cairo. Samples were taken before, during, and after the flood time, at about two months' intervals from July 10. The several numbers (for nitric acid) were, unexpectedly, 0·01, 0·0038, and 0·002 grammes per litre (of the last there is some doubt). He thinks the flooding of the Nile offers abundant material for study.—On the origin of sounds in the telephone, by M. Du Moncel. In most experiments showing that speech may be reproduced simply by a magnetic core surrounded by a helix, a microphonic transmitter with battery has been used. M. Du Moncel now shows the effect may be had with the induced currents of the Bell telephone, (made by Breguet). The receiver was a small strongly magnetised piece of watch-spring, fixed to a deal board, and surrounded by a small helix of fine wire. The diaphragm in the telephone, serving as armature, exalts the magnetic force of the bar, and is itself affected by the vibrations of the telephonic case fixed to one of the ends of the bar.—On the inter-oceanic maritime canal, by M. de Lesseps. He recounts the steps leading to the recent decision of the Congress; speaks hopefully of the work to which he is designated, and announces his purpose to make an appeal in all countries for a capital of 400,000,000 francs.—On the lines of sodium vapour, by Mr. Lockyer. Sodium vapour, after long distillation in vacuo, no longer gives the line D near the metal.—Widmanstaetten figures on artificial iron, by Prof. Lawrence Smith. He obtains them by heating a siliciuret of iron on lime with the gas blowpipe; the metallic button, after cooling, is placed in warm nitric acid.—M. Schiaparelli was elected Correspondent in Astronomy in room of M. Tisserand, and Prof. Huxley in Anatomy and Zoology in room of M. de Baer.—On a mode of transformation of ruled surfaces, by M. Mannheim.—Solar observations during the first quarter of 1879, by M. Tacchini. Of 35 days utilised, 32 figure without spots and cavities. The mean frequency per day was 0·33 (relative proportion greatest in January); this is less than in 1878, showing extension of the minimum. The hydrogenic protuberances also show diminution; they are nearly all in the northern hemisphere; the faculæ in the equatorial zone.—New arrangement for increasing the sensibility of the vibrating plate in the telephone, by M. Decharme. This consists in fixing the plate by its centre point alone, instead of by its border.—On a combination of alumina with carbonic acid, by MM. Urbain and Renoul. The composition (very unstable) is alumina, 52, carbonic acid, 11, water, 37; a hydrated sub-carbonate of alumina. Prof. Smith stated that the mineral, *Dawsonite* found at Montreal, is composed of carbonate of alumina and soda.—Influence of the pneumogastric and action of digitaline on the movements of the heart in sharks, by M. Cadiat. Digitaline acts as poison directly on the heart, causing tetanisation of the ventricle and diastole of the auricle.—On evolution of the embryo in eggs subjected to incubation in warm water by M. Dareste. He got such evolution to some extent in repeating the experiment of Reaumur (whose results were negative).—On a case of trichinosis observed in a young hippopotamus of the Nile, which died in captivity, by M. Haeckel.—M. Delecheneau described a modification of the phonograph.

CONTENTS

THURSDAY, JUNE 19, 1879

ELECTRIC LIGHTING

L'Éclairage Électrique. Par le Comte Th. du Moncel. (Paris: Hachette and Co., 1879.)

Electric Lighting and its Practical Application. By J. N. Shoolbred, M.Inst.C.E. (London: Hardwicke and Bogue, 1879.)

The Electric Light in its Practical Application. By Paget Higgs, LL.D. (London: Spon, 1879.)

THE little work, which now appears amongst the numerous volumes of the "Bibliothèque des Merveilles," though containing much more of real information than many of the sketchy works of that popular series, is somewhat disappointing. Like the other writings which the Comte du Moncel has given to the world, it displays a remarkable amount of industrious compilation, but the arrangement of the matter collected is somewhat cumbrous. A far superior book to his recent work on the Telephone, it is nevertheless marred by the same occasional confusion of thought exhibited in that work. It contains, however, in a small compass, a good deal of useful information, and enough serious reading to make it pass as a scientific book.

After fifty pages of generalities the author settles down to discuss the different systems of magneto-electric machines and their comparative efficiency. Next comes a chapter on "*organes excitateurs* de la lumière électrique," which we discover to include carbons of various manufacturers, and materials for lighting by incandescence. Then follow three chapters on regulators, incandescent lamps, and electric candles; after that a *résumé* of the cost of electric lighting; and finally a capital chapter on its numerous applications.

With regard to magneto-electric and dynamo-electric machines, great pains have evidently been taken to give a fair account of most of the systems of importance. In this respect the present work contrasts very favourably with that of M. Fontaine, in which such a disproportionate amount of space is allotted to the Gramme machines. Beginning with the early machines of Nollet, Wilde, Holmes, and Ladd, the successive inventions of Gramme, Siemens, de Meritens, Wallace, Brush, and Lontin are carefully explained, excellent woodcuts of most of these being appended. The "distributing" machines of Lontin, Gramme, and Jablochkoff are also noticed. We take exception to the statement that the Wallace-Farmer machine is merely an enlarged copy of those of Wilde and Lontin. It differs essentially from the former, and in point of date was earlier in the field than the latter. If there be one machine more than another that it does resemble, it is the machine of M. Alfred Niaudet, of which M. du Moncel makes no mention. On the very important question of the relative efficiency of the various systems, M. du Moncel has nothing to say that is new, but simply reproduces the tabular results published by the authorities of Trinity House and by the Committee of the Franklin Institute. His treatment of the question of the cost of electric lighting is even less satisfactory, the figures obtained as the result of the most recent experiments on a large scale in Paris and London being entirely omitted.

In treating of Regulators the author employs a classification deserving of attention. They are divided into six categories, viz.: (1) Regulators founded on the attraction of solenoids, as those of Archereau, Gaiffe, Jaspar, and Brush; (2) those depending on movements worked by electromagnets, as the lamps of Duboscq, Foucault, Serrin, Siemens, and Rapieff; (3) those with large circular carbons, as the regulators of Wright and Reynier; (4) those depending on hydrostatic reaction, as Way's mercurial lamp; (5) those depending on the reaction of the current itself, producing mutual repulsion between the carbon poles; and (6), lastly, those with fixed carbons, such as the electric candle of Jablochkoff. Lamps on the principle of incandescence so-called are treated of under a different head. The plate-lamp devised by Wallace is not mentioned. The following account of the process of manufacture of the Jablochkoff candles is new, and will be read with interest:—

"The manufacture of these candles carried on on a large scale at the Avenue de Villiers, where six or eight thousand a day are made, is really very interesting, especially the manner in which the insulating portions are fashioned. Upon a marble table slightly oiled is spread, by means of a moulding instrument made of a toothed strip of zinc fixed so as to slide in a suitable frame, a thin layer of plaster of Paris mingled with sulphate of baryta, and mixed so as not to set rapidly. This plaster is placed in front of the moulding instrument, which is then moved over the marble slab in such a way as to form grooves and ridges about two metres long. After the moulding tool has been passed backwards and forwards several times, a fresh quantity of plaster is placed in front of the instrument, thus increasing the thickness of the ridges; and at the end of five or six operations of this kind the ridges have exactly the thickness of the teeth of the moulding-tool, or that required for the insulator. The sides of these insulating strips are naturally made slightly concave to receive the carbons, which are cylindrical."

An account of the condensers employed by M. Jablochkoff in conjunction with the alternate-current generators that feed a series of candles, will also be found of some interest. M. du Moncel states that, without these condensers, the candle which has the least resistance of the four on one circuit absorbs so much of the current, that the other three are put out.

We have noticed, in perusing the work, a number of minor blemishes, which, should the book reach a second edition, might with advantage be removed. Thus we are told on p. 13, that Humfry-Davy (*sic*), in 1813, made the first experiments on the production of the voltaic arc, and that this discovery was "completed" by Foucault by the substitution of gas carbon for wood charcoal. If we remember rightly, Sir Humphry Davy's experiment in the Royal Institution, as recounted in the *Philosophical Transactions* for 1809, were made in 1808. Foucault's suggestion came in 1844.

What are we to understand by the following statement on p. 6?—"The *tension* of a current, *which is often nowadays confounded* (these italics are ours) with the *potential*, is the property of the electric fluid which gives in some sort the impulse of the electric movement . . . ." This statement may be put by the side of another on p. 15, that it is possible "to augment the intensity of a gene-

rator at the expense of its tension by condensing the charges."

Passing on to details concerning the light itself, we are told that the heating of the positive carbon to a higher temperature than the negative (an effect which, by the way, depends also upon the diameters of the two carbons) by the battery current does not take place with currents of high tension produced by induction machines. The author makes Professors Ayrton and Perry responsible for the statement that the resistance of the arc is 255 ohms.

Again, on p. 25 we read that the *Bunsen's* cell was discovered in 1839 by *Grove!* And, on p. 34, that to ascertain the resistance of the circuit a rheostat is employed. We had hitherto imagined Prof. Bunsen's battery to be a somewhat later device than that of Sir William Grove, dating from 1842 or 1843, and that for all practical purposes the unreliable rheostat had long been superseded by reliable resistance-coils. We rub our eyes mentally over these little matters.

In one of the appendices some excellent remarks of Mr. W. H. Preece are transcribed entire. In another a brief account of Mr. Edison's patent is copied from the *Standard*, with the following comment:—"This patent, practicable or not, exhibits the usual ingenuity of Mr. Edison, says the *Standard;* for our part we cannot share this opinion, and can see nothing new in the patent. It is a crude idea which does not seem to us likely to lead to any important results."

There is little doubt that to a large class of readers an English translation of this work will be acceptable. It will, however, require careful revision by a competent editor, especially in those passages—numerous to an almost irritating degree—where the reader is referred to the previous works of the author. If this be done the book will fill a useful place at the present time, when so much ignorance prevails as to the nature of the electric light.

Mr. Shoolbred's "Electric Lighting" is an expansion of the papers read by him before the Society of Arts and elsewhere, and professedly deals chiefly with the question from the point of view of practical application. Hence we have in this volume not only the well-known results of experiments on the cost of the light in tabulated form, but also paragraphs on such outlying subjects as photometers, gas-engines, and water-motors. All the principal machines and lamps are briefly described, and many of them figured on lithographed plates. Under the heading of Electric Candles, those of De Meritens, Wilde, and Rapieff are mentioned in addition to the well-known Jablochkoff "candles." Some account is also given of the chief experiments recently made in this country on the various systems of lighting. The manufacture of the carbon pencils for producing the arc is very briefly treated: too briefly, considering that this is the very point in which there exists at present the greatest room for improvement.

Some of the expressions used by Mr. Shoolbred strike us as warranted neither by their scientific accuracy, nor by popular usage. Thus on p. 95 we find, on the question of the subdivision of the light, the following sentence: "The product of each electrical circuit may, it would appear, be fairly considered as the *unit of output.*" On p. 96: "The *output* of a machine with regulators does not readily divide itself." This term "*output*," which in these instances, and on p. 11, is used for quantity of current generated by the machine, occurs again on pp. 65 and 66 for the amount of light emitted! The statement on p. 50 that "the very production of the electric light depends upon the conversion of a certain amount of mechanical *duty* into electrical *force*," would certainly draw down the wrath of sticklers for scientific accuracy. The suggestion to produce the voltaic arc between incombustible electrodes so as to avoid the production of nitrous fumes, "and *the very fact* that the use of *carbon* electrodes led to the development of *such baneful emanations*," can hardly be endorsed as a piece of chemical wisdom.

These blemishes, however, and a prevailing inelegance of style, show that a general acquaintance with a scientific subject will not alone qualify its possessor to be regarded as an authority.

For general merit and usefulness the treatise of Dr. Higgs on the electric light in its practical applications will take high rank. Avoiding historical details and points of abstract theoretical interest, the author begins by describing the various lamps and "burners" devised for producing electric light; he then goes on to enumerate the various generators, and to discuss their relative efficiency and economy, illustrating every point where possible by carefully tabulated results of experiment; and concludes with a notice of various useful applications. Many sources of information have obviously been laid under contribution: the report of the Franklin Institute, that of Professors Houston and Thomson, and the very valuable paper of Mr. Preece on the question of multiplication of lights, being reproduced almost entire. The recent and instructive report of Dr. Oëlhausen is also quoted in the chapter on Commercial Aspects. Chapter viii. is devoted to electric "regulators," a term which we discover the author to apply to devices, not for regulating the arc, but for controlling the strength of the current. He rejects the term "regulator" in its usual application, preferring to speak of electric "lamps" and "burners." On page 196 is given a table of the various and singularly divergent measurements which have been made of the intensity of illumination of the Jablochkoff candle. A summary of the report of the Gas Light and Coke Company's Committee is also given, and the prejudiced nature of that document is clearly demonstrated. A few blunders require attention. Thus the formula on page 198 for estimating the useful effect of distributed lights is hopelessly wrong. Again, while there is on page 169 a statement that the light is proportional to the current, we find on page 214 a sentence which would lead us to imagine the author's opinion to be that the light was proportional to the fourth power of the current! We doubt, too, whether it has yet been shown that "the hissing noise produced by the electric arc is due to the formation of a vacuum round the incandescent points." The statement that "a tuning fork with its prongs two yards in length will vibrate less than once in two seconds" is misleading, and not necessarily true. These defects apart, the book is a good one; and the illustrations, which are numerous, strike us as being, for the most part, superior to the average of those of scientific books. But why should the

author advertise himself as the *author* of "Electric Lighting," which is the title—if we are not mistaken—of his *translation* of Fontaine's well-known work?

SILVANUS P. THOMPSON

THE DOLOMITE REEFS OF THE SOUTHERN TYROL AND VENETIA

Die Dolomit-Riffe von Süd-Tirol und Venetien. Beiträge sur Bildungsgeschichte der Alpen. Von Edmund Mojsisovics von Mojsvár. Pp. 552, with 30 Photographic Plates, 110 Woodcuts, and an Atlas in 6 sheets. (Vienna: Holder, 1879.)

THERE are few districts in Europe which have attracted so much attention from geologists as that which is described in the splendid monograph now lying before us. Whether we consider the richness and variety of the palæontological treasures yielded by the world-famed deposits of St. Cassian, the wonderfully-dissected volcanic centres of Monzoni and Predazzo, or the remarkable illustrations of the action of denuding forces still at work in the Alpine regions, as illustrated by the picturesque ruin-like masses of the dolomitic limestones and the singular earth-pillars of Botzen, the area must be admitted to be worthy of the celebrity which it enjoys among the cultivators of all branches of geological science.

The author of the present work possesses a remarkable combination of the qualifications necessary for the successful accomplishment of the task he has set himself. A daring Alpine climber, he has explored the most inaccessible recesses of the district during the summer months, while his winters have been devoted to the study of the grand assemblage of fossil-forms which he has brought together with such untiring industry. The manner in which Dr. Mojsisovics is performing this task of describing the enormous series of fossils of the Alpine Trias—an assemblage of forms possessing so many features of interest on account of the remarkable admixture of Palæozoic and Mesozoic types which it presents—is familiar to all palæontologists. He has shown that at Hallstadt and St. Cassian respectively we have evidences of the existence of two distinct life-provinces in the Triassic seas, and his monographs on the cephalopods of these two life-provinces, the first instalments of which have already appeared, have excited the greatest interest among naturalists, who were scarcely prepared even by the writings of von Hauer and other illustrators of the fauna of the Alpine Trias, for the new and remarkable varieties of the Ammonite type, now brought to light by the author of this work. The current number of the *Verhandlungen der k. k. geologischen Reichsanstalt*, of Vienna, contains an interesting summary of this new work, and shows that no less than thirty-two Ammonite genera have up to the present time been recognised in the Alpine Trias, of which thirteen are peculiar to the northern life-province, five are restricted to the southern life-province, while fourteen are common to both. Although Dr. Mojsisovics's work has, up to the present time, been confined to the Cephalopoda, yet we anticipate results of scarcely less interest when he arrives at the examination of the Gasteropoda and the other classes of fossils obtained from the Alpine Trias.

The work before us is in great part the result of the investigation of the Austrian Geological Survey, carried on under the direction of Franz von Hauer, and much of the detailed examination of certain of the districts described was accomplished by two of the author's former colleagues Dr. Hoernes and Dr. Doelter; the account of the volcanic and granitic rocks is indeed almost entirely supplied by the latter geologist, who is so well known for his skill in micropetrographic researches. The most important part of the work, however, is that which is devoted to the description of the several Mesozoic formations of this Alpine area, and to a discussion of the important facts concerning the former physical geography of the region, and the distribution of life-forms within it—questions which the author is so well qualified by his long study of the subject to treat of.

As a consequence of the representations made to the Academy of Sciences of Vienna by von Hauer, Suess, and Hochstetter, a special grant of money was made to aid the author in the publication of this valuable monograph, and no expense has been spared to make both the book itself and the atlas which accompanies it, of the greatest possible value. In these respects the work resembles the publications of the American Geological Surveys much more than those of our own country.

The atlas contains six sheets, comprising an area of about 3,000 square miles, and is constructed on a scale of $\frac{1}{75000}$, or about $\frac{7}{8}$ of an inch to an English mile. The foundation of the map is, for the southern or Italian part, the old general map of the Austro-Hungarian Empire on the same scale, and for the Tyrolese area the new military map of Austria on a scale of $\frac{1}{25000}$, which has been reduced by photography. The geological colouring is admirably printed, and although between forty and fifty different tints have been employed to indicate the numerous subdivisions adopted by the author, this is accomplished without creating confusion, or obscuring the topographical details of the map. The district comprised in it includes the country lying between the Adige and the Piave, from Toblach, on the north, to Feltre, on the south, the larger portion of which is included in the Austrian Tyrol, but a considerable area in the south-west now belongs to the Italian monarchy.

The memoir itself is illustrated by thirty reproductions of photographs taken either by the author himself or by Egger of Lintz, the points of view in the latter cases having been chosen by Dr. Hoernes. These views give an excellent idea of the remarkable natural features presented by this very interesting district, the now famous "Dolomite Mountains." In addition to these views and the very numerous woodcut sections, there is also a series of maps illustrating the areas of the old coral reefs and the lines of disturbance traversing the district.

The first or introductory part of the memoir, consisting of four chapters, gives a general sketch of the geology of the district and of the physical features of the Southern Tyrol. The second part (Chapters V.–XV.) is devoted to a detailed description of the geological structure of the several districts, while the third and concluding part (Chapters XVI. and XVII.) deal with theoretical questions of great interest to geologists at the present time, namely, the reef-theory of von Richthofen and the origin and mode of formation of mountain chains. We regret

that the space at our disposal will not permit of our following the author in these interesting discussions, and we can only, in conclusion, heartily recommend the work to the traveller as being admirably adapted to guide him in investigating the geology of a district of extreme interest and great complexity, and to the student at home as containing numerous facts and suggestions worthy of the most thoughtful consideration. J. W. J.

HEALTH PRIMERS

Health Primers. Edited by J. Langdon Down, M.D., F.R.C.P., Henry Power, M.B., F.R.C.S., J. Mortimer-Granville, M.D., John Tweedy, F.R.C.S. (London: Hardwicke and Bogue.)

THE proverb that a little knowledge is a dangerous thing is especially true in regard to matters connected with health, and it might therefore be supposed that the issue of a series of health primers was a thing to be deprecated, as likely to do harm. But a little reflection will show that this series is intended, not to impart a little knowledge, but to replace the knowledge, not merely little, but confused and inaccurate, which every man supposes himself to possess, by something more definite and exact. Every one fancies that he knows the appearances of health and disease, and that he is able to decide upon the condition of those whom he daily meets. Every man supposes himself able to pronounce that such and such a house cannot be healthy, and believes that he is quite capable of judging for himself how much exercise he ought to take, whether he should or should not use a cold bath in the morning, and what is the proper allowance of beer, wine, or spirits, either for himself or for his neighbours. Now, despite the confidence with which most men will pronounce an opinion on all these subjects, the data on which they would found that opinion would really be very slight, and their knowledge of the subject probably very imperfect and inaccurate, and, consequently, the conclusions at which they would arrive would most likely be erroneous. It is just on such subjects as those we have mentioned that the books of this series afford accurate information. The first of them, "On Premature Death, its Promotion and Prevention," is of a less popular character than the others, and has, we think, suffered in consequence of its author not having seen the contents of the other primers. While the material it contains is very valuable, it deals, we think, too much with statistics and too little with the causes of premature death which are under the control of the individual, although occasionally, however, it gives these also, as at p. 46, where ventilation in a hospital is said to have put a stop to the convulsions from which the children died in great numbers, and reduced the mortality to $\frac{1}{28}$ of its previous amount. But on the other hand, while we learn that 6 per cent. of the total mortality from all causes is due to diseases of the heart, the writer says nothing of the dangers incurred in running after an omnibus or in trying to catch a train.

The primer on "Personal Appearance in Health and Disease" includes the changes which the body may undergo in the form and size of its bony framework, fatty layer, and internal organs, as well as external colour. These are given shortly and well, though the alterations produced artificially by tight-lacing and high-heeled and tight boots might have been still more strongly insisted upon and emphasised by woodcuts showing their results.

"The House and its Surroundings" is clearly written, and contains a great deal of very useful information. By its aid the householder should be able to know where to look for defects in drainage, ventilation, water supply, &c., and thus to avoid many sources of disease, although we think that the dangers of arsenical wall-papers ought perhaps to have been more strongly insisted upon.

"Baths and Bathing" discusses the physiological action, varieties, and uses of baths and bathing localities, both at home and abroad. It is written in a very readable style, and contains both advice as to the use of baths and cautions in regard to their abuse. The author warns against the too heroic use of a morning tub, but forgets to state how very much the chilliness which it brings on in persons of languid circulation may be prevented by using a bath sheet instead of a towel, so that the whole body shall be covered during drying, and not chilled by the exposure of the wet skin to the cold air.

"Exercise and Training" gives a general account of the changes produced in the body by muscular exertion, of the food required, the general *régime* to be pursued, and the dangers to be avoided. It is evidently written by one who is familiar with the subject of which he is treating.

"Alcohol, its Use and Abuse," deals with a very difficult subject, and does it well. The author is not prejudiced either for or against alcohol, and maintains that because ninety-nine persons out of a hundred misuse it, it is none the less true that it has a right use, this use being sometimes to check the current of thought and care, as well as to stimulate digestion and circulation, although in perfect health its use is unnecessary.

The purpose which these primers are intended to serve is a very important one, and we think that they are well calculated to serve their purpose. We have pointed out one or two things in which we think they might be improved in future editions, but on the whole they are well and carefully done, giving accurate information in a condensed yet popular form. T. L. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Mechanical Theory of Earth-Heat

NOTICING the assertion made in NATURE, vol. xx. p. 22, in reference to Prof. Church's article in *Silliman's Journal* on the Comstock Lode, that "the rock in the lower levels seems to have a pretty uniform temperature of 130° F.," and remembering what Prof. G. F. Barker, of the University of Pennsylvania, told me, that on a recent visit to those mines he found that there was no uniform temperature, but on the contrary, the most remarkable differences, some of the higher levels being much hotter than some of the lower levels—so that he came to two conclusions:—(1) That the heat was a hot water heat, and (2) that the hot waters were heated mechanically by those continuous movements of the country, so plainly shown both in the mines and at the surface;—it occurs to me to ask the following question:—

Has any one, in the discussion of Mallet's hypothesis, thought of bringing its probability to such a test as the volatilisation of the hydrocarbons of coal-beds in a highly plicated region like Belgium?

It is a remarkable fact, and one which seems to me inconsistent with the mechanical theory of earth-heat, that of two extensive regions, Belgium and Eastern Pennsylvania, equally and excessively disturbed by complications, all the coal-beds of the one are anthracite, and all those of the other are bituminous.

Again, of two regions equally undisturbed, Western Pennsylvania and Arkansas, the horizontal coal-beds of the one are bituminous and of the other anthracite.

Surely, if movements of stratum on stratum produce all the needful heat, *no* plicated coal-beds should escape being converted to anthracite; and I should much like to hear from English geologists how this argument is to be met. My own explanation of the origin of anthracite is not worth much, but it is the best I know. I refer such origin to three causes acting in conjunction—(1) Heat due to superposed (now wholly or partially removed) Permian and later formations; (2) Greater proportion of sands in the anthracite and of clays in the bituminous coal-measures; and (3) Plication and fracture, permitting the exit of volatilised hydrocarbons into the atmosphere.

American Philosophical Society, Philadelphia, May 22 — J. P. LESLEY

Evolution Old and New

MR. A. R. WALLACE writes, in NATURE, vol. xx. p. 143, that, according to the theory which I support, Australian (and more especially Queensland) sheep should show a tendency to grow a scantier and thinner fleece than their English ancestors. "If Mr. Butler," he continues, "could adduce on good authority such a fact as this, he would have some evidence in his favour, instead of which he can only make suppositions."

I never was in Australia, but had some years' experience of sheep-farming in New Zealand. It was generally believed, in my time, that fleeces soon became short and hairy in Queensland, and even in the more northern part of New South Wales. You must, however, have many readers who could tell us what the facts are. May I hope that you will kindly insert this, so as to get the matter settled by eliciting information from a competent authority? I am speaking, of course, of sheep that are left to the effect of the climate, without being frequently crossed with rams from colder countries. Do the fleeces of such sheep deteriorate in Queensland? — S. BUTLER

June 12

The River Elbe

IN NATURE, vol. xiv. p. 498, some particulars are given of measurements made in 1871 and 1872 of the water flowing past in the Elbe at the boundary between Saxony and Bohemia. The river basin in Bohemia above this point is stated at 880 square miles, which is evidently wrong, as the annual discharge of 6,179,000,000 cubic metres (218,223,743,000 cubic feet) would give a depth of 107·64 inches run off the ground. Measuring roughly on the map, the area of Bohemia—which, apparently, all drains into the Elbe—is 20,000 English square miles. If, on the other hand, the measurements of the river water and the solids in solution and suspension are correctly given, and the river basin is 20,000 square miles, the rainfall must have been exceptionally low at the time the measurements were taken, as the figures represent only about half that of the mean annual flow off the ground in the Danube basin, which is 9·06 inches. Perhaps the writer of the notice will be able to find out how these discrepancies occur. I may add that, taking the figures as given in NATURE, 607 tons per square mile per annum are removed in solution in the Elbe water. From a district composed mostly of silurian rocks, this is manifestly absurd. According to my calculations,[1] 72·7 tons per square mile are annually removed in solution in the Danube water.

Blundellsands, June 17 — T. MELLARD READE

Electric Light

IN NATURE, vol. xx. p. 110, an account is given of Sir William Thomson's evidence on the electric light. It is stated "that one horse-power had produced 1,200 candles of actual visible electric light, whereas one horse-power of energy would only produce 12-candle gas-light." In the report of Sir J. W. Bazalgette and Mr. Keates to the Board of Works, which is probably the best report we have yet had on the subject, as to the actual cost of the electric light on the Thames Embankment, it is stated that the cost of the electric light was 5·75*d.* per hour, whereas the cost of the gas required to produce a light equal to the electric light as regards illuminating power, in an opal globe, was 2·00*d.*, and in a frosted globe 3·50*d.* per hour. Would any of your numerous readers be kind enough to give me some idea of the qualifications to be appended to the above statements, which will reduce the long odds calculated by Thomson of 100 to 1 in favour of the electric light, to the odds of 2 to 1 against it as found in actual practice? In conclusion may I venture humbly to suggest that such conflicting statements as the above, if unexplained, are apt to bring the dicta of scientific men into disrepute with the thinking portion of the general public. — F. J. M. P.

[1] "Geological Time," *Proceedings* of Liverpool Geological Society, Session 1876-7.

The Climbing Perch

THE aquarium of the Zoological Society's Gardens in Regent's Park has lately received a contribution of five specimens of the "Climbing Perch" (*Anabas scandens*). They were very kindly obtained for me by my friend, Mr. A. Ferguson, of Colombo, Ceylon, and were brought home in excellent condition by my brother, Mr. A. F. Dobson. Mr. Ferguson (who is so well known in Ceylon as a naturalist of great experience) kept the fish for some months in an aquarium, and trained them to take chopped meat from the hand, so that they were in the best possible condition for their long journey.

The first specimens of this fish which arrived alive in Europe were sent by me from Calcutta in 1872 to the Royal Zoological Gardens in the Phœnix Park in Dublin, where they lived for a considerable time.

I have described (P. Z. S., 1874), in my paper "On the Respiration of Indian Fresh-water Fishes," the manner in which *Anabas scandens* takes in, and rejects again, the atmospheric air, and on a visit to the aquarium in the Gardens the peculiar conduct of these fishes when respiring may be witnessed by any one.

Mr. Ferguson informs me that he has specimens of some species of *Ophiocephali* and the remarkable *Arius bakeri*, which carries its young in its mouth, in training, and I hope soon to have an opportunity of having them safely carried to England.

Netley, June 14 — G. E. DOBSON

Oxygenated Rain

ON Thursday, June 12, at half-past eleven in the morning, a remarkable shower of rain fell over London, which might almost be described as "effervescing;" the drops whilst falling appeared to be colourless and perfectly transparent, but on striking against any solid surface they became milky, and on close examination it was evident that this cloudy appearance was caused by a number of very minute air-bubbles, which rapidly increased in size, and then burst. From the bleaching power which this rain appeared to have, I am led to believe that there was nascent oxygen in the gas thus evolved. Those who traverse the streets of London in the early morning may now and then observe the red colour of all bright iron-work in the pavement, such as coal-plates, &c., due to the oxidising influence of a thunder-shower in the night; this effect does not follow every thunder-shower, but seems to indicate a peculiar atmospheric condition. Have any memoranda on this subject been recorded? — EDWARD SOLLY

WILLIAM FROUDE[1]

LAST week we called attention to Mr. Froude's discoveries of those laws of motion of floating bodies, upon which the behaviour and safety of a ship passively floating among sea waves depends. We now purpose giving a brief outline of his researches in another branch of hydrodynamics by which he arrived at a true appreciation of the nature and amount of the resistance opposed by water to the passage of a body like a ship through it. In connection with the resistance of ships, the subject of marine propulsion, which Mr. Froude has also done much

[1] Continued from p. 150

to elucidate and bring within the grasp of scientific treatment, will naturally find a place.

The resistance of ships and the speeds that could be relied upon in practice by the application of a given amount of force has always been a fruitful source of trouble to naval architects and engineers. The various formulæ that have been used for calculating the speed of ships, and which were based upon what were supposed to be the true laws of resistance, have always been uncertain and unreliable in their application. Mr. Froude has shown that this is because the approved formulæ "were not only wrong in detail, but that the supposed cause of resistance, with which alone they professed to be dealing, was in reality no cause at all; and that the real cause of resistance, whatever it might be, was entirely left out."

This supposed cause of resistance, which "was in reality no cause at all," was alleged to be due to the inertia of water, and the necessity for pushing those particles out of the way which offer an obstruction to the progress of a ship through the fluid. Thus it seems that there must be an excess of pressure upon the fore part of a ship when she is excavating or pushing water out of her way; and a diminution of pressure or partial vacuum on the after part when she is travelling away from the particles which press against her. There would therefore be a total resistance caused by excess of pressure forward and deficiency of pressure aft. As this resistance would depend upon the volume of water that would have to be pushed out of the ship's way; it appeared obvious that it must be measured by the area of the ship's cross section.

These considerations were expressed in the following formulæ, which have been those chiefly used by shipbuilders till the last few years, and have been preferred by the Admiralty to any other down to the time when they placed the determination of the speeds of ships in Mr. Froude's hands. The formulæ are—

$$V^3 = \frac{C_1 A}{P} \text{ or } = \frac{C_2 D^{\frac{2}{3}}}{P}.$$

when $V =$ the speed of the ship, $A =$ the area of the greatest immersed cross-section, or "the area of the ship's way," $D =$ the ship's displacement, $P =$ a measure of the propulsive force, which stands for the indicated horse-power of the engines, and C_1 and C_2 are constants obtained from the observed performances of other ships. These are only formulæ of comparison between different ships, and were always regarded as being strictly applicable only to the comparison of ships of similar form. They are obviously based upon the assumption that the resistance is as the square of the speed and the area of the vessel's way, or of the canal she may be supposed to cut through the water in going from place to place. This is strictly the assumption in the first formula, which includes the exact area of the immersed cross-section of the vessel; but in the second formula, though the character of the assumption is the same, the area is corrected to represent the supposed equivalent cross-section for variations of displacement.

These formulæ gave fairly accurate results when applied to vessels of good form which were similar to those from which the constants were derived, and when the speeds were low. It was known, however, that the speeds of vessels of exceptional form and dimensions could not be thus calculated, and that in all ships the resistance increased at a faster rate than the square of the speed beyond certain limits, which limits were different in different ships. The development of the true laws of fluid motion, or the doctrine of stream-lines, by Prof. Stokes, Prof. Rankine, Sir William Thomson, and others enabled the real causes of a ship's resistance to be ascertained. It was then seen to be quite wrong to suppose that the work done in propelling a ship is in any degree analogous to excavating a canal, and spreading the water she successively displaces over the surface.

The stream-line theory showed that the reactions which the inertia of the fluid would cause against the surface of a ship moving through it arranged themselves quite differently to what had formerly been supposed, and that such methods of estimating their total effect—which was supposed to constitute the resistance—as we have referred to were fundamentally wrong. Indeed it shows that there is nothing in nature to correspond with the old idea ot head resistance, because, according to the stream-line theory, a submerged body such as a fish, or a torpedo, once put in motion in a frictionless fluid would continue to travel with an uniform speed, and experience no resistance. Certain particles of fluid would have to be set in motion to enable such a body to pass them, but this would be done in such a way as to cause no resistance in the direction of motion. The backward forces acting upon the body on some parts of its surface would be balanced by the forward forces acting upon other parts, and the inertia of the fluid would propel it forward at some points with an equal force to that opposed in resistance at other points.

Mr. Froude showed most clearly and conclusively how this paradoxical result came about in his presidential address to the mechanical section of the British Association delivered at Bristol in August, 1875,[1] and also in a lecture delivered at the Royal Institution on May 12, 1876. He proves that in a perfect or frictionless fluid there is no power by which any endways resistance can be caused to the passage of a submerged body moving uniformly through it. Substituting for the submerged body moving through a stationary ocean of fluid the plainly equivalent conception of a stationary submerged body surrounded by a moving ocean of fluid, Mr. Froude points out that at a sufficient distance ahead of the body the ocean is flowing steadily on, in what may be imagined to be a collection of streams of any size and cross-section we please. All these streams must have the same direction, velocity of flow, and pressure. In order to get past the body these streams must alter their direction and velocity, settling themselves into courses which will be determined by the various reactions they exert upon each other and upon the surface of the body—"yet ultimately and through the reverse operation of corresponding forces, they settle themselves into their original direction and original velocity. Now the sole cause of the original departure of each and all of these streams from, and of their ultimate return to, their original direction and velocity, is the submerged stationary body; consequently the body must receive the sum total of the forces necessary to thus affect the streams. Conversely this sum total of force is the only force which the passage of the fluid is capable of administering to the body. But we know that to cause a single stream, and therefore also to cause any combination or system of streams to follow any courses changing at various points both in direction and velocity, requires the application of forces the sum total of which in a longitudinal direction is *nil*, provided that the end of each stream has the same direction and velocity as the beginning. Therefore the sum total of the forces (in other words, the only force) brought to bear upon the body by the motion of the fluid in the direction of its flow is *nil*."

A frictionless fluid would, therefore, offer no resistance to a submerged body moving through it. Mr. Froude next introduced the consideration of friction, which brings two causes of resistance into play. First, there is the friction proper which is due to the drag of the particles of water upon the surface of a body as it moves through it, and which is governed in amount by the area of the surface, and also by its nature, whether smooth or otherwise; and secondly, there is the defect of pressure at the rear end of the body caused by the stream, line motions being somewhat impeded by friction between the

[1] Published in NATURE of November 18, December 2, 16, and 30, 1875.

particles. This is very obvious in blunt-ended bodies where the stream-lines, instead of closing in round the rear end and exerting their due pressure in the direction of motion, force themselves into eddies and whirls. Mr. Froude calls this element of resistance "eddy-making resistance." It is imperceptible in ships of fairly easy shape, but is of large amounts in ships with very full sterns. He shows that a submerged body of good easy shape would practically experience no resistance except that due to surface friction, and the amount of resistance would be practically the same as that of a thin plane moving edgeways, which has the same area of wetted surface.

Mr. Froude next shows that when we come to the case of a ship or a body travelling at the surface, a new cause of resistance is introduced, due to the system of surface-waves which is generated. The variation of pressure in the stream-lines formed at the sides of a ship relieves itself at the surface by raising or lowering the level, and thus a bow and stern wave with a depression amidships are formed and carried along as the ship progresses. These waves once made, however, require little force for their maintenance, so long as they are not swollen to abnormal dimensions by the increased wave-making tendency a ship possesses at high speeds. Other systems of waves are also generated and driven off from the ship in various directions by features of form that interfere with the natural courses of the stream-lines. There are, therefore, three great causes of resistance to a ship: 1, surface friction; 2, eddy making; and 3, wave genesis. Mr. Froude shows that the first, viz., surface friction, practically agrees with the resistance experienced by a plane of the same wetted surface drawn longitudinally through the water at high speeds, and that the eddy-making resistance is practically nothing in well-formed ships having fine ends; but that the wave-making resistance is so indeterminate in its character as to be incapable at present of direct calculation.

Mr. Froude estimated the total amount of a ship's resistance by means of careful experiments with a model made to her exact form. The method of doing this with accuracy is one of Mr. Froude's greatest and most useful discoveries. Model experiments of this nature that had previously been made were so misleading that it was generally believed to be impossible to infer the resistance of a ship from that of a small scale model. Mr. Froude saw, however, that all three elements of resistance followed the same laws in similar bodies, whatever the differences of size might be, and that all that was required to make experiments with models reliable was to discover the true scale of comparison. This scale, or law of comparison, he discovered, and stated as follows:—"If the ship be D times the 'dimension' (as it is termed) of the model, and if at the speeds V_1, V_2, V_3 .... the measured resistances of the model are R_1, R_2, R_3 ...., then for speeds $\sqrt{D}\,V_1$, $\sqrt{D}\,V_2$, $\sqrt{D}\,V_3$ .... of the ship the resistances will be $D^3 R_1$, $D^3 R_2$, $D^3 R_3$ .... To the speeds of model and ship thus related it is convenient to apply the term 'corresponding speeds'"; the special feature of this "correspondence" being the fact that at such speeds precisely similar wave systems are generated by ship and model.

Mr. Froude tried in 1867 a large number of resistance experiments with models of various forms and dimensions, by towing them from the ends of 10-foot scale beams, connected with self-recording dynamometric apparatus, and mounted on booms projecting sideways from the bow of a steam-launch. Some of the results were in glaring contravention to the ordinary principles current at the time, and Mr. Froude invited Mr. E. J. Reed, C.B., M.P., who was then Chief Constructor of the Navy, to witness the experiments. Mr. Reed saw the necessity for fresh investigation, and by his recommendation a further series of experiments was sanctioned by the Admiralty.

These experiments were brought into further prominence by the action which was taken upon a report of a committee of the British Association in 1869, upon the stability, propulsion, and sea-going qualities of ships. On the recommendation of this committee an application was made to the Government for carrying out experiments upon resistance with actual ships of considerable size. Mr. Froude, who was a member of the committee, dissented from this report on the ground that the various elements of resistance and the laws of their operation "could be discovered with far greater facility and completeness by small-scale than by full-size experiments." The Admiralty requested Mr. Froude to conduct an extensive series of experiments with models; this he undertook and continued up to the time of his death with the greatest skill and success. The results thus obtained furnished data for determining the resistance of ships of various forms and dimensions to a considerable degree of exactness, and also showed what circumstances were favourable to speed and what were not.

This subject had an important bearing upon some of the inquiries instituted by the Committee on Designs for Ships of War, in 1871, and they requested the Admiralty to determine experimentally the actual resistance of a full-sized ship. The Admiralty accordingly ordered the requisite experiments to be made upon H.M.S. *Greyhound*, a vessel of about 1,150 tons displacement. The experiments were made under Mr. Froude's superintendence. The *Greyhound* was towed by H.M.S. *Active*, and the resistance at various speeds recorded by means of a delicate dynamometric apparatus. She was towed from the end of a long outrigged boom, so as to be clear of the wake of disturbance, and every possible precaution was adopted to eliminate all the various sources of error. The experiments verified to a remarkable degree the law of comparison propounded by Mr. Froude as governing the relation between ships and their models, and perfectly justified the reliance he had placed upon his method of investigating the effects of variation of form by trials with varied models, a method which, as Mr. Froude afterwards remarked, "if trustworthy, is equally serviceable for testing abstract formulæ, or for feeling the way towards perfection by a strictly inductive process."

The value of Mr. Froude's method of calculating the speeds of ships from those of their models, became so obvious, that the Admiralty discarded their old methods, and referred their designs to Mr. Froude for his estimate of their speeds. Besides the elaborate series of experiments which Mr. Froude has had in course of procedure at his experimental tank at Torquay for determining the best form and proportion for various classes of ships, designed for various speeds, most of the new Admiralty designs have been experimented upon and modified forms suggested where improvement could be made. The results of his work, and especially of the recent trials of H.M.S. *Iris*, whose lines were determined by Mr. Froude for the high speed of 17½ knots—have borne striking testimony to the correctness of his work.

Mr. Froude has, however, done much more than show how to calculate with accuracy the speed of a ship from that of her model. He has shown how the various elements of resistance act upon a ship at given speeds, and the laws upon which they depend. In well-formed steamers the resistance at low speeds consists almost entirely of surface-friction. This was the case in H.M.S. *Greyhound* at a speed of eight knots. If a curve of total resistance be made from experiments with a ship or model, and a curve of frictional resistance be also placed on the same base line, they will be found almost identical at their low speeds. The resistance due to the formation of eddies is so small in well formed ships as to be hardly appreciable. When a ship of tolerably fine lines is moving at a moderate speed, the whole resistance, therefore, consists of surface-friction. As the speed

is increased, the curve of total resistance ascends more or less above the curve of frictional resistance, and in some cases departs very largely from it. The rate of departure as the speed increases differs largely in different ships, and in vessels of the same section, but of different lengths. Mr. Froude conducted a series of experiments upon models of the same cross section and form of ends, but with the length successively increased by lengths of parallel middle body. These models corresponded to ships of lengths varying from 160 feet to 480 feet in total length. At the lower speeds, up to about eleven knots, the resistance increased by about equal increments with equal increments of length of the ship, but at higher speeds this harmony disappeared. At thirteen knots the 200-feet ship makes considerably more resistance than the 240-feet ship, and at $14\frac{1}{2}$ knots the 200-feet ship makes almost as much resistance as a 360-feet ship of 2,275 tons more displacement. Similar anomalies appear in the comparison between other ships. These were shown by Mr. Froude to be due to the influence of wave-making resistance, and to depend upon the positions occupied with reference to the stern of the ship by the waves generated by the bow. The practical point involved is that a ship may sometimes be lengthened considerably without any loss of speed for the same application of power; whereas if the conditions favourable to this are not complied with, she may, on the other hand, require a disproportionate increase of power to keep up her speed. Mr. Froude has shown how the most favourable conditions can be realised in this respect.

These investigations into the resistance experienced by ships at different speeds have thrown great light upon that long-disputed problem in naval architecture, "the form of least resistance," and has gone far to enable shipbuilders to arrive at the best form and proportions for the speed required, which is compatible with other requirements. Economically such a discovery is of great value in enabling more work to be done in steamship propulsion for a given engine-power and expenditure of fuel.

Mr. Froude's dynamometric experiments upon the resistance of the *Greyhound*, and some results of the steam trial performances of other ships, showed him that the actual resistance of a ship was much less than had been generally supposed. At eight knots speed the pull upon the tow-rope of the *Greyhound*—a ship of 1,150 tons displacement—was only $2\frac{1}{2}$ tons, and at ten knots $4\frac{3}{4}$ tons. This was so very much below the thrust the screw was supposed to exert when driving the ship at those speeds, that Mr. Froude set to work to investigate the relation between the indicated horse-power of marine engines as represented by the work done by the steam in the cylinders, and the power that is usefully employed in propelling the ship. He found, as the result of many experiments, that in ordinary ships at full speed the former is 2·7 times the latter, or that the effective horse-power, as given out by the thrust of the screw, is only $37\frac{1}{2}$ per cent. of the power indicated in the cylinders.

Mr. Froude decomposed the indicated horse-power of the engine into its constituent parts, and approximately quantified each element as follows:—

1. The useful thrust or ship's true resistance = E.H.P. or the effective horse-power.

2. The augmentation of the ship's resistance by the induced negative pressure under the stern consequent on the thrust of the screw. Mr. Froude often called attention to this cause of resistance, and showed that it might be greatly reduced by placing the screw a short distance abaft its usual position. He ascertained by experiment that with ships of ordinary form the resistance is increased on account of the action of the screw by about 40 or 50 per cent. of her nett resistance. The power required for this therefore = 0·4 E.H.P.

3. The friction of the screw blades in passing through the water, which was found to be = 0·1 E.H.P.

4. The constant friction due to dead weight and the tightness of the moving parts. This is at all speeds about one-seventh of the total load of the engines when working at full speed and pressure. It is therefore = 0·143 I.H.P., I.H.P. being the total indicated horse-power.

5. Friction due to working load of engine. This is also = 0·143 I.H.P.

6. Air-pump resistance. This is approximately equal to 0·075 I.H.P.

Summing up these several elements it will be found that the effective horse-power at full speed is little more than $37\frac{1}{2}$ per cent. of the indicated horse-power.

This analysis of the manner in which the power of the engines is employed is very valuable in indicating the manner in which loss of power may be treated in detail, and also in furnishing a reliable means of comparison between the efficiency of different engines. It will take time to come into general use, but cannot fail to do so as it becomes understood and appreciated. Already some of our most intelligent shipbuilders, such as Mr. Denny of Dumbarton, and Mr. Inglis of Glasgow, have applied Mr. Froude's theories to practice, and are working upon the improved methods he has laid down both for increasing the effect in the propulsive power of the engines, and in diminishing a ship's nett resistance.

The general adoption of these theories will be a great boon to science, as well as a practical benefit, in point of economy to the ship-builder and ship-owner. Science will benefit by having the performances of ships recorded in such a manner as will be available for correcting the present theories, and throwing light upon such laws of hydrodynamics as are yet undiscovered or but imperfectly understood.

One great difficulty in making any scientific use of steamship performances has arisen from the absence of any method of determining the power delivered to the screw. All that was ever ascertained was the power indicated in the cylinders, and, as we have seen, this was found to be enormously in excess of the effective power employed in propulsion. As the problems of resistance and propulsion can only be accurately treated by dealing with the thrust exerted by the screw, it became desirable to have some means of measuring this in actual ships. Mr. Froude, who had frequently pointed this out, was asked by the Admiralty to devise a dynamometer that would measure the power delivered at the end of the screw shaft in large marine engines. The problem was a most difficult one, but Mr. Froude solved it in a most complete and admirable manner. He described the instrument he had invented in a paper read before the Institution of Mechanical Engineers in July, 1877, and a description of it is given in NATURE, August 2, 1877. It fulfils all the conditions of giving a true indication of the power, being simple, compact, and easy of application. A machine for dealing with an engine of 2,000 I.H.P. is all included in the circumference of a circle of three feet radius, and as its power increases as the fifth power of its linear dimensions, it can be applied to any size of engine without becoming unduly large.

We have glanced hastily over some of Mr. Froude's achievements in science, but it is impossible within the limits at our disposal to do more than glance at them, or even to refer to many. He was a scientific worker of the best and rarest type, and was constantly employed in perfecting the details of his theories or striking out new lines of thought. He was a master of the delicate art of experimental and theoretical investigation, and a study of his work would show many perfect examples of the manner in which, by induction, a knowledge of the causes of phenomena may be arrived at. Being an excellent mechanic, and a most conscientious and ingenious experimentalist, Mr. Froude put all his theories and

hypotheses to the most crucial and varied practical tests, and conclusively proved their truth, or determined the limits of error involved by them. He had the power of arranging almost intuitively simple experiments for qualitatively testing the value of an idea, and his mathematical knowledge and power of close and accurate reasoning enabled him to work out the quantitative results of a difficult problem with great facility. His experimental tank at Torquay, with all the delicate and interesting contrivances in connection with it for measuring and recording the behaviour of models in rolling or their resistance to motion through the water is a marvel of philosophical arrangement and practical skill. Mr. Froude's published papers include but a small portion, we believe, of his work. It would be a worthy tribute to his memory, and a great boon to science and to the shipping interests of the country if the result of his researches could be published in a complete form, and thus made readily accessible.

Mr. Froude had not much encouragement during the early days of his investigations upon these subjects. The first to appreciate their value were the late Prof. Rankine and Mr. Crossland, one of the constructors of the Navy. Mr. Crossland was one of the first to see that Mr. Froude, in his first paper on the Rolling of Ships, read before the Institution of Naval Architects in 1861, had indicated the true laws of rolling motion, and in the following year he contributed an original paper upon the same subject. Mr. Reed was the first to apply the principles enunciated by Mr. Froude to the construction of ships; and did so with great ability and success. Canon Moseley, Dr. Woolley, and others did not see, however, for a considerable time, that Mr. Froude had made a great stride in advance of previous knowledge, and had really discovered the means that had long been wanted of arriving at a due comprehension of the dynamical laws which govern a ship's behaviour at sea. Mr. Froude's lucid and painstaking explanation of his theory and replies to the objection of Dr. Woolley and others produced in due time their full effect, and in the course of a very few years all who were capable of understanding the arguments upon which the theory was based were thoroughly convinced that Mr. Froude's method and its results were sound, and were such as could alone lead to improvement in this branch of science.

Mr. Froude's scientific reputation and the value of his work now rest upon a solid foundation. His discoveries have revolutionised whole theories of hydrodynamics, and have stood the test of practical application. He has received various honorary distinctions, such as the degree of LL.D. from the University of Glasgow, and the Royal Medal of the Royal Society; but his greatest distinction, and that with which his name will always be associated, is that, in an age when science is fashionable and many of its professors look more to the show than the substance, Mr. Froude devoted his energies to a long and unwearied search after truth in a department of science that few knew anything about, and that could have no interest for the many, and he looked only to success for his reward. Happily, in this sense he was bountifully rewarded, and has left, both in the subject-matter of his researches and the example he set in pursuing them, a legacy to those who follow after which should stimulate them to work with all their might, with the one object of endeavouring also to attain unto truth and to be worthy of being admitted within the veil of the temple of nature.

KARL KOCH

THERE are very few even among professed botanists, who avail themselves to any thing like the extent they might do of the teachings of a garden. And yet for the study of the life-history of plants and for the due estimation of their precise degree of relationship one to the other a garden offers in some ways—in many ways—unrivalled opportunities.

Karl Koch, whose death we lately recorded, was one of the few who had a right appreciation of the resources of a garden and who knew how to turn them to account. His tall, attenuated form and keen eye were to be observed at most of the International Botanical and Horticultural Congresses which have been held in various continental cities and in London in 1866. Everywhere, by horticulturists as by botanists, his claims to high rank among his fellows and his title to respect and even affection for his personal qualities were acknowledged, so that it became a pain to those who saw him recently to notice his gradually failing powers and to see how the old spirit was curbed and checked by impaired physical health.

Karl Koch was born in Weimar in June, 1809. In that little capital he came in contact, as a youth, with Goethe, and it was partly owing to his influence and advice that Koch made his visits to the Caucasus and various parts of Asia Minor. Shortly after he had completed his studies in medicine and natural history at Jena and at Würzburg he set out on his travels, his special objects being the investigation of the vegetation and an inquiry into the original sources of our cultivated fruit-trees. After two years' research he suffered so severely from the effects of sunstroke on Mount Ararat that he was obliged to return to Jena, but in 1843 he set out a second time for the East. Of his first journey an account was published in 1842, under the title of "Travels through Russia," of his second, in 1845, under that of "Wanderings in the East." A general account of his travels may be found in the *Linnæa* for 1848, in which publication also may be found catalogues and descriptive lists of the plants collected by him, together with remarks on the geographical distribution of plants in the Caucasus, &c. On his return from this second expedition he became assistant-director of the Botanic Garden at Berlin, secretary of the Prussian Horticultural Society, and, a few years later, Professor of Botany in the University.

His position at Berlin gave him exceptional facilities for studying cultivated plants, and, accordingly, much of his botanical work consisted of monographs of Arads, Bromeliads, Agaves, and other plants, necessarily imperfectly preserved in herbaria. Many such monographs are scattered through the *Wochenschrift* of the Berlin Horticultural Society, and which was for many years edited by him. As a pomologist also he held no mean position, but the most interesting and valuable part of his labours, so far as this branch is concerned, are those relating to the origin of cultivated fruit trees, a subject intimately connected with the history and migrations of our own race.

His *magnum opus*, however, is his "Dendrology"—a scientific description of the trees and shrubs cultivated in the forests and gardens of central Europe, a work for which his travels had well prepared him. For the purpose of compiling this volume Koch visited almost every country in Europe. All the great nurseries of the Continent and of our country were also inspected by him with the object of study or of securing specimens.

Despite small defects of method Koch's descriptions are excellent and characteristic, so much so, that it is a great pity that his work has not been translated into English. The technical details of his subject are enlivened by short biographical notices of the botanists and horticulturists whose names are the most prominently associated with the department of botany, of which his work treats. The reader of these interesting notes to an otherwise necessarily dry technical book will have no difficulty in understanding the estimation in which Koch's popular lectures on trees and on fruit trees in particular were held by the Berlin public.

In private life Koch was beloved for his uprightness, loyalty, and warm-hearted devotion to his friends.

THE ELECTRIC DISCHARGE WITH THE CHLORIDE OF SILVER BATTERY

MESSRS. De La Rue and Müller, in the second part of the researches which they have carried on during three and a half years, have contributed facts of the highest value towards the solution of the problem presented by the beautiful phenomenon of stratification produced by electric discharges in vacuum tubes. The following are some of the more important results of these experiments as described by the authors.[1]

These phenomena, first noticed by M. Abria in 1843, were independently re-observed by Mr. (now Sir William) Grove in 1852, and have since engaged the attention of many physicists. The late Mr. Gassiott, working at first with an induction coil, but more recently on the same lines as the voltaic batteries of high potential,[2] published results of great interest; while, on the other hand, Mr. W. Spottiswoode is still pursuing with great acumen and originality a similar investigation, both with the induction coil and the Holtz machine, with which he has recently used condensers of great capacity.

Throughout our labours we have felt so strongly the necessity of obtaining numerical results as data for the foundation of a theory, that we have not hesitated to risk much in this cause. By the fusion of terminals, or the sudden discharge of the condenser, we have lost a vast number of very beautiful tubes; but gradually by the adoption of various devices, and by the employment of instruments specially constructed and insulated to suit the high potentials we deal with, we have succeeded in overcoming the various impediments, so that we can now readily obtain values for the physical quantities that enter into consideration in our experiments.

There is a serious trouble connected with the study of the discharge in rarefied gases, for, after a very short time, the tubes completely and permanently change, so as no longer to present the splendid stratifications witnessed on a first trial. We believe these changes occur much more rapidly with the battery in consequence of the greater amount of current, than with the induction coil; but the fact appears to have been well known to Dr. Geissler, of Bonn, who, on the occasion of a visit to our laboratory, brought with him some tubes through which no current had previously passed (virgin tubes, as he called them), which presented most beautiful phenomena lost for ever after too brief a period.

Tube 123 (cyanogen), for example, when first connected with the battery, presented strata which completely filled the tube without leaving a dark space near the negative, some threading themselves on it, as shown on the left of Fig. 1; but after a few seconds the strata widened out as on the right hand figure, then other changes occurred, and the first phases have never been reproduced.

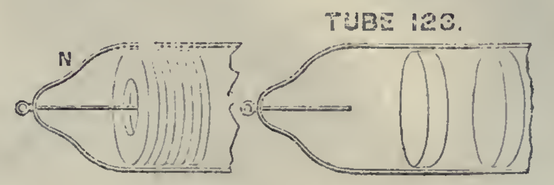


FIG. 1.

Another case is presented by the nitrogen tube Fig. 2, the right-hand figure showing the first phase, and the left-hand figure a second phase, which in its turn has for ever disappeared, and has been replaced by the ordinary disk-form of strata.

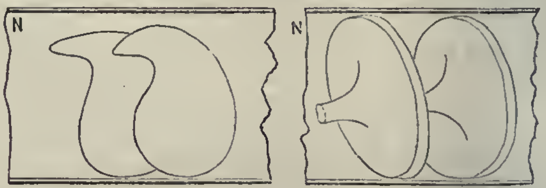


FIG. 2.

After spending much time in experiments with tubes prepared for us by Dr. Geissler, Messrs. Alvergniat Frères, of Paris, and Mr. Hicks, of Hatton Garden, with the vexation of finding that we could not often enough repeat our experiments, we ultimately came to the conclusion to have others made, but not exhausted, and to perform ourselves the charging and exhaustion. The tubes we usually employ have a glass stop-cock fitted to them at each end; they are 32 inches long, and from 1·75 to 2 inches in diameter; the terminals are of aluminium, and about 29 inches apart, one being a ring, the other a wire bent at a right angle, so as to point in the direction of the axis of the tube (see No. 144, Fig. 3), for we have found that the phenomena vary according as the ring or wire is made positive.

FIG. 3.

These we exhaust and fill with any gas we may wish to experiment with, and gradually exhaust again, noting the phenomena presented at different pressures, with different potentials, and with different amounts of current. We re-fill and exhaust the tube again and again, and mostly obtain, under the same conditions, as nearly as possible the same phenomena, of which we are careful to make sketches and, if possible, to obtain photographic records.

In some cases we make use of tubes provided with a calibrated chamber between two stop-cocks, as *a—b*, No. 145, Fig. 4, the chamber in this particular case having $\frac{1}{2200}$th of the capacity of the tube, this tube has also an absorption chamber communicating through a cock and intended to contain spongy palladium. After a tube has been exhausted so as to produce a particular phase, and in the course of the experiment the exhaustion has been carried beyond that degree which permits of the reproduction of that phase, one or more charges of gas may be successively admitted into the tube by filling the calibrated chamber with gas at any particular pressure, and then opening the stop-cock communicating with the tube; the lost phase is thus reproduced.

The apparatus which we have found it advantageous to adopt for the exhaustion of our tubes is shown in Fig. 5; it comprises three means of exhaustion which are successively employed as the vacuum becomes more perfect. The first is an Alvergniat high-pressure water *trompe* in connection with the high-pressure water-main of the

[1] See *Phil. Trans.*, vol. clxix., pp. 55-121.

[2] Mr. Gassiott made several batteries of different kinds in the course of his experiments; on the occasion of a visit to his laboratory, January 26, 1875, the current of his Leclanché battery was measured by us with a voltameter. The current of 1000 new cells was found to be 0·07464 W; that of the whole 3000 cells, 1000 of which had been a long time in use, 0·04718 W. Taking the Leclanché as 1·48 volt the internal resistance of the new battery must have been 19·83 ohms per cell; that of the whole 3000, 31·87 ohms per cell. The striking distance of the whole 3000 between a conical point and a disk 0·125 inch diameter was only 0·125 inch; whence the inference is that the insulation was, at that time, imperfect.

West Middlesex Water Company, the head of water being 106 feet; it produces a vacuum to within half-an-inch (0·47 in. = 12 millims.) of the height of the barometer. The pipe leading to it is so marked in the drawing; it is attached, through a cock, to a four-way-junction-piece F, provided with three more cocks, communicating:—one to one end of the tube T, one to the last drying bottle of the gas generator G G′, and one to a mercurial gauge. The

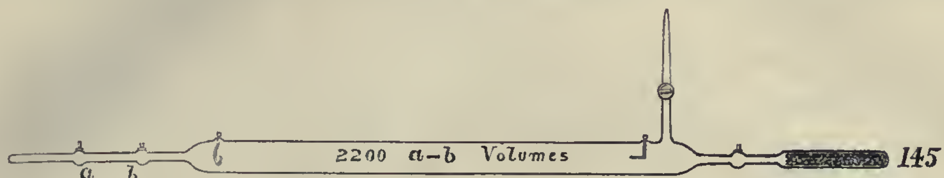


FIG. 4.

other end of the vacuum tube T communicates by means of a Y-piece to both, an Alvergniat mercurial pump, on the right of the figure, and a Sprengel pump, on the left. After the *trompe* has done its work, the Alvergniat is used for rapid exhaustion, and then shut off by means of the glass cock C, leaving the exhaustion to be completed by the Sprengel; we have thus obtained, by the *pumps alone*, in tubes 32 inches long and 2 inches in diameter, vacua of only 0·002 millimetre pressure, equal to 2·6 millionths of an atmosphere—a vacuum so perfect that the current of 8040 cells would not pass. The apparatus is in connection with a McLeod gauge, by means of which pressures to 0·00005 mm. can be determined. Besides this gauge, the Sprengel and Alvergniat pumps have their own gauges, which read to a millimetre. M is a rotating mirror consisting of a four-sided prism mounted on a horizontal axis and provided with a multiplying wheel; on each face of the prism is fastened a piece of looking-glass. The reflection of the tube in the mirror enables one to examine

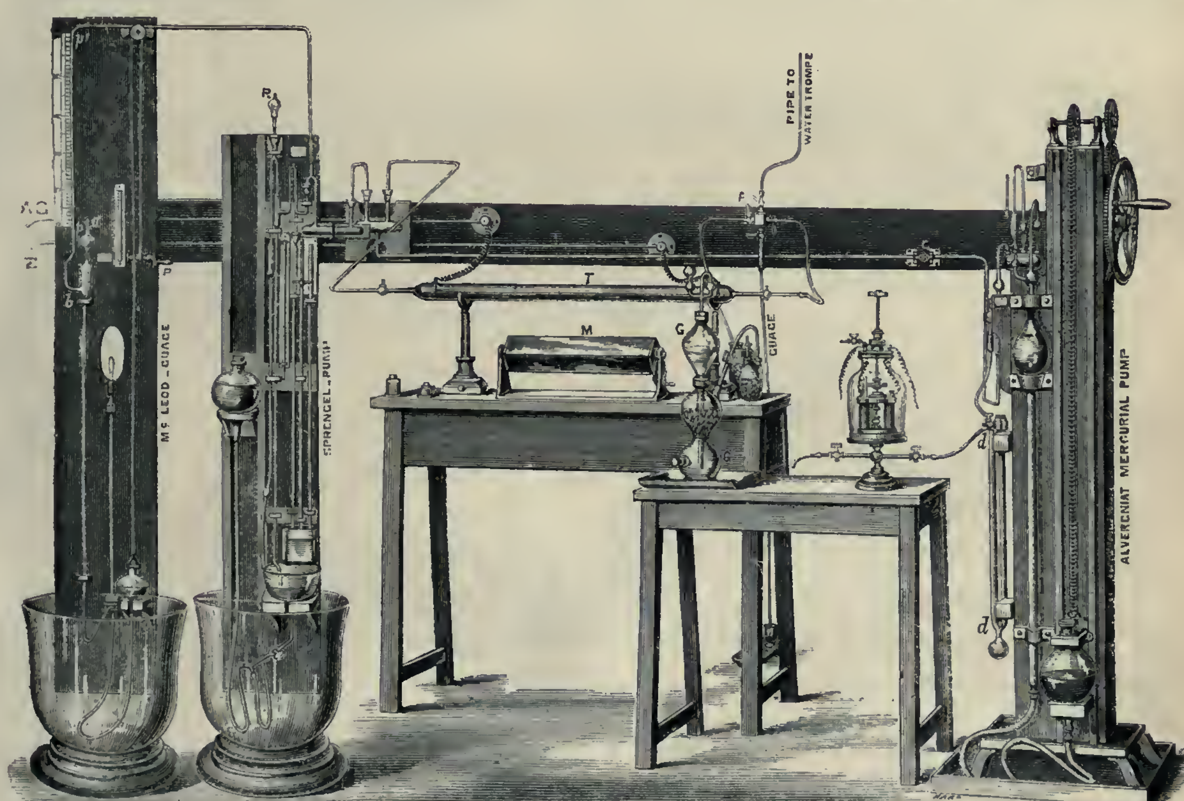


FIG. 5.

whether an apparently nebulous discharge is simply nebulous or consists really of strata, also whether and in what direction there is a flow of strata which may appear quite steady to the eye. The observations are facilitated by covering the tube with a half cylinder of cardboard having a slit in the direction of its axis about $\frac{1}{10}$ inch wide. R is a radiometer attached to the Sprengel; *d*, *d*, a drying tube containing sticks of potash used when gas is introduced from a reservoir through the Alvergniat.

The resistance of vacuum tubes does not depend solely or mainly on the distance between the terminal, but it does greatly on their diameter.

In order to test how much of this depends on the length of any constriction, we had made two tubes, 154 and 155, Fig. 6, of nearly the same length (16 inches), and internal diameter $\frac{15}{16}$ths of an inch, the residual gas in each case being carbonic acid, CO_2. From results obtained with these tubes where the constricture varied in length in the ratio of 125 to 1, it became evident that the main effect is due to the simple constricture of the tube.

The diagram Fig. 7, shows the arrangement by which,

in our early experiments, we measured the resistance of a tube. The tell-tale tube[1] had to be substituted for the galvanometer in the ordinary Wheatstone bridge, as the difference of potential between C and D fluctuated greatly

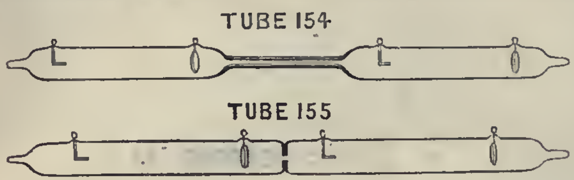


Fig. 6.

in the course of the experiment, causing violent swings of the needle.

A Z is the battery, the A terminal of which is connected at A′, in the bridge arrangement, with two equal fluid resistance tubes, FR and FR′, of 420,000 ohms, placed in vessels containing ice, to keep them at a constant temperature; an adjustable coil resistance is inserted between B and D; the tube T T′, to be tested, is placed between D

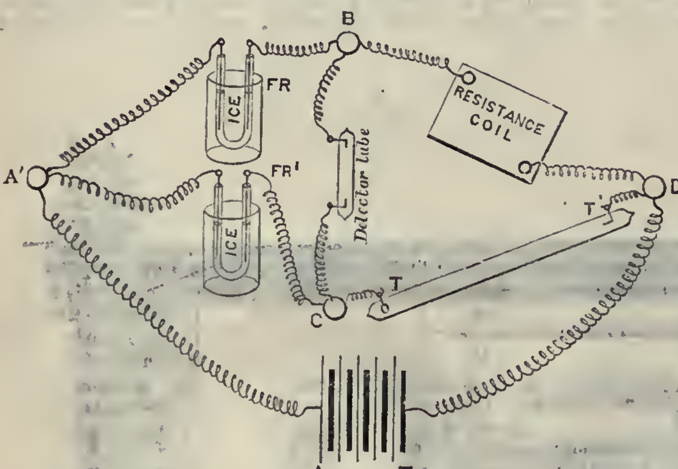


Fig. 7.

and C, the Z terminal of the battery being connected to D. When the resistance is greater or less than that of the tube to be tested there is an illumination in the detector tube between B and C; but when a current passes in T T′, balanced by a proper adjustment of the coil resistance, then the glow in the detector ceases. It was ultimately found that the detector tube might be suppressed because, as soon as the resistance in B D is a little in excess of that of the tube, the latter gives evidence by its illumination of the current passing. After the current in a tube has commenced it is generally found that it will continue to glow, even when some of the balancing resistance, B D, is plugged out in the coil box, showing that when once started the *working* resistance becomes less. If, on the other hand, the current has been stopped entirely, it requires generally a greater balancing resistance in the coil box between B D to start it again than it did in the first instance. After standing for a short or long time it regains its normal condition, but the interval required may amount to several days. The following numbers were obtained:—

Tube	Started with ohms.	Ran up to ohms.	Nature of the Gas.
1	200,000	250,000	
2	350,000	500,000	
6	270,000	500,000	N
42	15,000	70,000	N
81	150,000	infinity.	CO_2
95	700,000	1,000,000	SiF_6

Subsequently we found it to be more convenient not to make special determinations of the resistances of the tubes beforehand in the way just described, but to obtain them by reproducing the deflection of a galvanometer by substituting wire resistances for the tube, or by measurements taken with an electrometer in the manner to be described, while observing the phenomena of stratification.

From measurements thus made with a tube having several rings about 1 inch apart (No. 25, like in Fig. 9), or a Spottiswoode tube with a shifting terminal (No. 147, Fig. 8), we found that the resistance of a vacuum tube, unlike that of a wire, does not increase in the ratio of the distance between the terminals for the same gas at the same pressure.

In making these experiments it was noticed that the resistance for equal distances appeared to be greater in proximity with the negative pole than in other parts of the tube, and fresh experiments were in consequence undertaken to ascertain the potential at the several rings by means of a delicate Thomson-Becker quadrant electrometer furnished with an induction plate, I, Fig. 9, which may be adjusted to any required distance from the quadrant beneath it.[1] The tubes employed among others were No. 25, described above, and two other longer tubes, namely, No. 149 (CO_2) with 12 rings 2 inches apart, and No. 150 (CO_2) with 17 rings also 2 inches distant. The current was led through a metallic resistance to the first ring, the last ring and the other pole of the battery being to earth. It was found that the greatest difference of potential occurs between the last ring and the last but one on the negative side, the next greatest difference being between the last and the last but one on the positive side, but the difference in the former case is far greater than in the latter; in some cases there is little or no difference

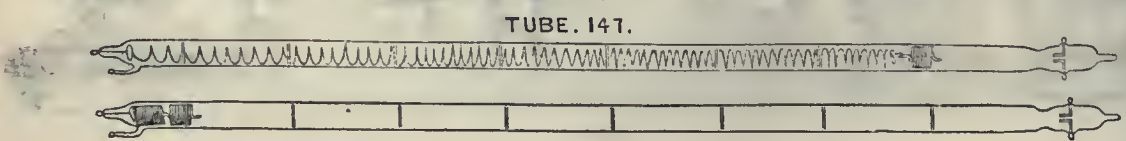


Fig. 8.

in the last but one and the last but two on the negative side; in these cases the last but one on the negative side was dark, while all the others had a luminosity about them. The difference of potential between the rest of the rings is sensibly uniform.

The following observations, made December 21, 1877, with tube 150, may be taken as an illustration of the method of measurement adopted. Batteries 6 and 7 (2,400 rod cells) were employed, and adjustable resistances were inserted in circuit for the double purpose of affording the means of readily varying the strength of current without interruption, and of enabling a measurement of that current to be made with the electrometer. The connections are shown in the diagram, Fig. 9.

[1] A tube selected for the readiness with which it permits the passage of a current of 440 cells.

[1] It has since been found more advantageous to separate the induction apparatus from the electrometer. Each pair of quadrants is charged with opposite electricities by means of two separate batteries of twenty chloride of silver cells, the opposite poles being to earth; and the induced plate of the induction apparatus communicates with the needle.

NEGATIVE POSITIVE

D.J. Pound Sculpt.

FAC-SIMILE OF PHOTOGRAPHIC

The circuit was first broken by removing the earth wire from ring 17, and the plug T, in connection with the induction plate I, being touched at any point between K′ and ring 1 gave the reading for "Full Potential, open circuit;" next, the earth wire was replaced at ring 17, and the value for "Full Potential, closed circuit," was obtained by causing T to touch at K′. As these batteries had but small internal resistance, the difference between these two readings was scarcely perceptible. By touching T at rings 1, 2, &c., in succession, their potentials were observed. The current was then reversed and similar observations were made. Next, for the purpose of

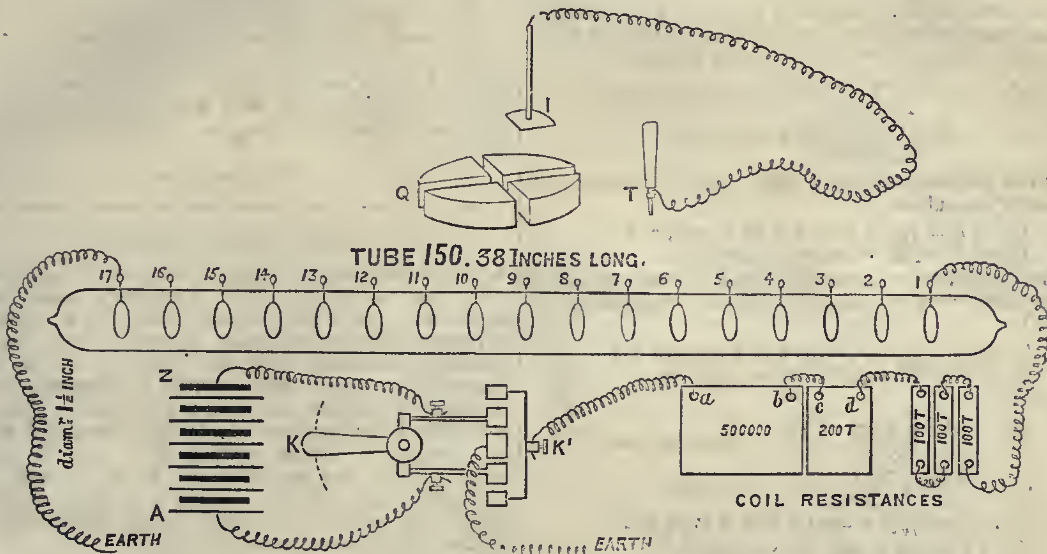


FIG. 9.

making a better examination of the tube in detail, the induction plate I was lowered to that distance which gave as large a deflection for the difference of potential between the two ends of the tube as was convenient. After the potentials of the several rings had been measured in succession with both currents, the induction plate was restored to its original position, and one or two of the first observations were repeated for confirmation. The current was then varied by altering the resistance in circuit,[1] and fresh measurements made in the same order. Thus the following values were obtained:—

I. CIRCUIT:—2,400 rod-cells, 1 megohm resistance, Tube 150: Induction plate at 2 inches distance from the quadrant

	Current +	Differences.	Current −	Differences.
Zero	6 right = 0		6 right = 0	
Full potential (open circuit) ...	154 left = 160	 1	200 ,, = 194	 2
(closed ,,) ...	153 or 4 ,, = 159		198 ,, = 192	
Potential at ring 1	106 ,, = 112	 47	133 ,, = 127	 65
,, ,, 2	96 ,, = 102		108 ,, = 102	
,, ,, 3	not observed		100 ,, = 94	
,, ,, 4	,,		95 ,, = 89	
,, ,, 5	,,		89 ,, = 83	
,, ,, 14	26 left = 32	 112	not observed	 127
,, ,, 15	20 ,, = 26		25 right = 19	
,, ,, 16	16 ,, = 22		20 ,, = 14	
,, ,, 17	6 right = 0		6 ,, = 0	

II. Circuit varied by substituting 800,000 ohms for the 1,000,000 ohms of wire, and inserting liquid resistance No. 3 (2,690,000 ohms) between the wire resistance and ring 1.

	Current + 1st Observation.	2nd Observation.	Mean Differences.
Zero	5 right = 0	5 right = 0	
Full potential (open circuit)	159 left = 164	159 left = 164	 1
,, (closed ,,)	159 or 8 ,, = 163	158 ,, = 163	
Potential after 800,000 ohms	139 ,, = 144	138 ,, = 143	... ... 19·5
,, at ring 1	112 right = 117	111 ,, = 116	 27
,, ,, 2	not observed	103 ,, = 108	
,, ,, 3	,,	97 ,, = 102	
,, ,, 4	,,	90 ,, = 95	... ... 116·5
,, ,, 15	,,	25 ,, = 30	
,, ,, 16	,,	18 ,, = 23	
,, ,, 17	5 right = 0	5 right = 0	

	Current − 1st Observation.	2nd Observation.	Mean Differences.
Zero	5 right = 0	5 right = 0	
Full potential (open circuit)	194 ,, = 189	192 ,, = 187	 1
,, (closed ,,)	193 ,, = 188	191 ,, = 186	
Potential after 800,000 ohms	166 ,, = 161	167 ,, = 162	... ... 25·5
,, at ring 1	138 ,, = 133	136 ,, = 131	 132
,, ,, 17	5 ,, = 0	5 ,, = 0	

[1] This method of varying the current is arranged to save time. The circuit must not be interrupted in the course of a set of observations.

III. The induction plate was lowered from 2 inches to $1\frac{1}{2}$ inch. Current $-$. (The current $+$ was not observed for want of time.)

Ring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Readings	276	217	200	187	174	159	144	130	116	104	90	76	62	48	35	22	0
Differences	59	17	13	13	15	15	14	14	12	14	14	14	14	13	13	22	

The observation III. illustrates that which has already been said concerning the fall of potential within the tube.

In case I. we have for the currents in webers—

$$C+=\frac{\frac{47}{160}\times 2400\times 1\cdot 03}{1,000,000}=0\cdot 0007261, \text{ and}$$

$$C-=\frac{\frac{65}{194}\times 2400\times 1\cdot 03}{1,000,000}=0\cdot 0008281,$$

and for the difference of potential in volts (V) between the two ends of the tube—

$$(C+)\,V=\tfrac{112}{160}\times 2400\times 1\cdot 03=1730, \text{ and}$$
$$(C-)\,V=\tfrac{127}{194}\times 2400\times 1\cdot 03=1618.$$

These differences of potential would be reproduced if for the tube were substituted metallic resistances in ohms (R)—

$$(C+)\,R=\tfrac{112}{47}\times 1,000,000=2,383,000, \text{ and}$$
$$(C-)\,R=\tfrac{127}{65}\times 1,000,000=1,954,000.$$

In case II.—

$$C+=\frac{\frac{19\cdot 5}{164}\times 2400\times 1\cdot 03}{800,000}=0\cdot 0003674, \text{ and}$$

$$C-=\frac{\frac{25\cdot 5}{188}\times 2400\times 1\cdot 03}{800,000}=0\cdot 0004190.$$

$$(C+)\,V=\tfrac{116\cdot 5}{164}\times 2400\times 1\cdot 03=1756, \text{ and}$$
$$(C-)\,V=\tfrac{132}{188}\times 2400\times 1\cdot 03=1736.$$
$$(C+)\,R=\tfrac{116\cdot 5}{19\cdot 5}\times 800,000=4,780,000, \text{ and}$$
$$(C-)\,R=\tfrac{132}{25\cdot 5}\times 800,000=4,142,000.$$

Selecting the observations with the current positive in each case and placing these in juxtaposition thus—

	C		V		R
Case I.	0·0007261	...	1730	...	2,383,000
,, II.	0·0003674	...	1756	...	4,780,000

we see that when C is varied in the ratio of 2 : 1, V remains sensibly constant, R varying as 1 : 2; that is to say, though the current is halved, the difference of potential between the ends of the tube remains constant —a condition which could only be brought about when metallic resistance is substituted for the tube, by doubling this resistance.

This points to the important conclusion that *other things being kept constant* and the current alone varied, we should find the value of V *strictly* constant for all values of C; but it may readily be imagined that in experiments with "vacuum tubes" it is not easy to ensure perfect constancy of the accompanying circumstances.

To test this conclusion we extended the range of our observations by varying the value of C as much as from 1 to 135.

In the paper are given the original measurements themselves, not the mean results, in order that the discrepancies in the readings obtained for V when C was kept as constant as our powers of control permitted, might be compared with the variations, such as they are, in the values of V when the circuit was purposely varied so as to produce currents of different strengths. Our observations show clearly that discharge through rarefied gases cannot be at all analogous to conduction through metals; for a wire having a given difference of potential between its ends can permit one—and only one—current to pass; whereas, from the measurements obtained it became evident that with a given difference of potential between the terminals of a given vacuum tube, currents of strengths varying from 1 to 135 can flow. We are therefore led to the conclusion that the discharge in a vacuum tube does not differ essentially from that in air and other gases at ordinary atmospheric pressures—that it is, in fact, a disruptive discharge.

By fixing small rings of tinfoil to the glass near the places where the metal terminals are fused into the tube and connecting these rings to earth, we were able to cut off the leakage over the surface (which, in spite of precautions, is considerable), and prevent it from interfering with our measurements of the potential of the gas *inside* the tube.

(*To be continued.*)

NORTHERN BORNEO

SOME time ago (NATURE, vol. xviii. p. 454) we were able to give a few particulars respecting the acquisition, by a British association, of a considerable portion of Northern Borneo, a region which has never yet been thoroughly explored. Under the title of "North Borneo," the promoters of this association have just printed for private circulation a 4to volume, containing a sketch of the territory of Sabah, lately ceded to them, and a report on various portions of the same by a Ceylon planter, which are accompanied by an analysis of soils and three appendices. The volume also contains two maps of Borneo, but the details given therein about the northern part are necessarily meagre.

The territory of Sabah comprises an area of some 18,000 square miles, possessing the great advantage of a coast-line of 500 miles from the Kimanis River on the north-west coast, to the Sibuco River on the east side of the island; it has the finest and almost only good harbours in Borneo, viz., Gaya Bay, Ambong, and Ousukan Bay on the west, and Sandakan Harbour on the east coast, the first and last named of which will, no doubt, become of great importance, especially if it be true that there is coal close at hand. The whole of Sabah is traversed by a mountain range of 5,000 to 8,000 feet in height, which culminates in the Kini Balu mountain, 13,700 feet high. To the east of this is the supposed position of the Kini Balu Lake, which no European has yet visited. On the shores of the lake, according to native reports, there are many villages of Ida'an, who cultivate cotton, tobacco, &c., and are said to be peaceful and industrious. There are numerous rivers on the north-west coast, but owing to the proximity of the high mountain ranges they are said to be only navigable by light craft; on the east coast, however, there are several splendid rivers, the Paitan, Sibuco, and Kinabatangan, the latter of which is believed to be navigable by large steamers for several hundred miles. As far as has been at present ascertained, the spurs and slopes of the Kini Balu range seem well fitted for the cultivation of coffee, tea, and cinchona, and the level country on the banks of Kinabatangan for sugar, indigo, tapioca, tobacco, cocoa, cotton, and rice. The Sabah territory is believed to be but sparsely peopled, the total population being estimated at 150,000 to 200,000; the interior is inhabited by descendants of the aborigines, called variously Muruts, Dusuns, or Ida'an, and corresponding in their external appearance in many respects to the Dyaks of Sarawak and the southern parts of the island, though they are of a lighter hue. The climate of the region is believed to be very favourable; in the plains and low-lying lands near the sea and rivers an invigorating breeze is generally felt during the day, the thermometer seldom ranging beyond 86°, while the nights are cool, with a temperature sometimes below 70°. No data are yet available in regard to the rainfall, but it is believed to be very similar to that of Ceylon. The soil is rich and fertile, and in many locali-

ties of superior quality. The chief vegetable productions indigenous to the soil and growing wild in the forests are india-rubber and gutta-percha, baroos camphor and gum damar, and many valuable kinds of hard-wood timber. Rice, millet, tapioca, Indian corn, sugar-cane, tobacco, cotton, pepper, and many kinds of tropical vegetables are cultivated by the natives. The sago palm is found in abundance, cassia lignea is met with in some localities, and cocoa-nuts, the areca palm, mangoes, limes, oranges, bananas, and pine-apples are plentiful. Under the head of animal productions the report mentions edible birds'-nests, beeswax, hides and horns of cattle and deer, mother-o'-pearl shell, seed pearls, bêche de mer or trepang, and tortoise-shell; elephants exist in the Kinabatangan province in large numbers; rhinoceros, numerous deer of large and small breeds, and wild pigs are met with in many parts, but beasts of prey of the feline species appear only to be represented by a small cheetah in the interior. Minerals will, doubtless, be found in abundance in Northern Borneo. Gold occurs in several localities. Borneo diamonds are famous for their purity and water, and it is believed that they exist in Sabah as well as in Dutch territory. Tin, antimony, coal, quicksilver, iron, copper, petroleum, and other valuable minerals and metals, there is reason to believe, will be found in the territory of the association, but there has not yet been time for even a partial exploration of it from a geological and mineralogical point of view. The labour question may cause some little trouble. The population near the coast consists of Malays, Lianuns, Bajous, Sulus, and others of a mixed breed who are lazy, indolent, and averse to manual labour of any kind. The aborigines in the interior, Dusuns and Ida'an, are peaceful and docile, and accustomed to a certain kind of labour. But the company will not have to rely upon either for the development of their territory, for, as the report puts it, "the enormous amount of labour waiting for employment in the Chinese Empire, not more than three or four days' distance by steam from North Borneo, is at the disposal of intending planters and others . . . on reasonable terms."

VULCANOLOGY IN ITALY IN 1878[1]

A FEW years ago Cav. Michele Rossi, brother and collaborateur of the well-known author of "Roma Sotterranea," determined to try the experiment of collecting together from all parts of Italy facts connected with Vulcanology, and publishing an account of them in the form of a monthly fasciculus. He hoped by this means to found a new school for the study of endogenous meteorology, to be affiliated with the study of meteorology proper. The experiment has succeeded admirably, and we have before us a volume of 140 pages, recording all the phenomena of internal telluric dynamics which have been observed in Italy and Sicily during the past year. The vulcanology of Sicily, notably of Etna and the eastern sea-board, is also recorded in the Acts of the Accademia Gioenia of Catania. In no other part of Europe, except Iceland, would it be possible to have a journal solely devoted to the volcanic phenomena of one country. The kingdom of Italy contains within it the two most famous volcanoes in the world; it contains solfataras, soffioni, and maccalube; it is subject to earthquakes, sometimes of great severity, and spread over large areas; the district between Naples and Cape Misenum embraces almost every phase of volcanic phenomenon, excepting only the geysirs, and the Stufe di Nerone belong to this class of effects. Hence, obviously, there is no country of equal accessibility in the world which is so well adapted for the study of vulcanology.

The *Bullettino* opens with a tribute to the memory of Padre Angelo Secchi, which is followed by a proposition to erect a monument to his honour. We were glad, a few weeks ago, to notice that a well-executed bust of the great Roman astronomer had already been placed among those of the many celebrities which adorn the Pincian Hill. The new monument will probably take the form of a *monumento meteorologico*, to be erected in Rome.

A list of twenty-six Italian observatories in which seismic observations are recorded is given in the *Bulletino*, with the names of the observers, who are in direct communication with Prof. de Rossi. Among the minor notices we find mention of the proposed railway to the observatory of Vesuvius; of various new seismological observatories, including that of the Solfatara at Puzzuoli; and of the earthquake which was simultaneously felt at Fiumalbo, Florence, and Rocca di Papa. Bibliographical notices and correspondence find a place at the conclusion of the fasciculus. In the next number we find letters on the application of the microphone to seismological studies, from Prof. Michele Rossi and Count Giovanni Mocenigo, and later in the volume a very interesting article by the former details his experiments on the subject. The Umbrian earthquake of September, 1878, receives full description at the hands of Prof. Arpago Ricci; Silvestri gives an account of the mud eruption which broke out on the sides of Etna near Paternò in December; and Palmieri continues his "Cronaca Vesuviana" to the end of September, 1878. An exact account of the time of occurrence of earthquake phenomena in any part of Italy is entered in a tabular form, and it is surprising to notice that not a day passes in Italy without some indication of endogenous dynamic action. This also proves to us the sensibility of the instruments. The date is given, then the hour, the place, and the nature of the observation, thus:—

"13.—0.08 a. Messina, forte.—Reggio di Calabria, due scosse.—Palmi, scosse.—Capo Spartivento, molto forte.—Tropea, leggera ondul.

1.15 a. Corleone, leggera E—O, rombo.
5.50 a. Tolmezzo, debole; altra poco dopo.
7.15 a. Narni, sensibile N O—S E.
Mattina Rocca di Papa, leggerissima.
11.15 a. Bologna, leggerissima."

At the conclusion of the volume there is a large table showing at a glance the daily distribution of earthquakes throughout Italy. Twelve vertical divisions correspond to the twelve months of the year, and these are further divided by small lines into days. The horizontal lines serve to indicate:—

1. In the uppermost portion of the diagram the height of the barometer in millimetres. Thus we have the barometric curve for each month.
2. Here also is shown the variations during each month of the level of the water in the wells of Leghorn and Porretta.
3. Earthquakes according to the latitude.
4. Earthquakes according to the longitude, east and west of the meridian of Rome.
5. Daily maxima of the force of the shocks.
6. Phases of the moon.
7. Daily maxima of the number of the shocks.

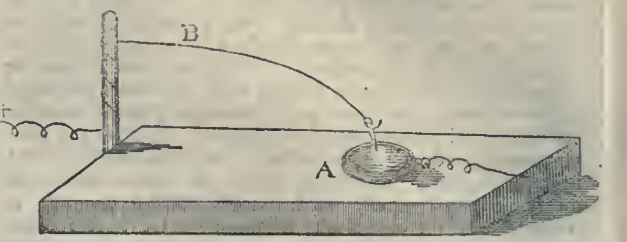
In Prof. Michele Rossi's seismological observatory in Rome we saw at work a set of instruments devised by himself for registering both vertical and horizontal shocks. These are not the same as Palmieri's instruments, and are said to be more sensitive. In both sets of instruments the general principle is the same. The shock, by its movement, communicates motion to some appliance, such as a pendulum, or a column of mercury in a bent tube, which establishes electrical communication with a recording instrument. In the latter a ribbon of paper is drawn at a definite rate over a drum, and whenever electrical contact is established a small electro-magnet becomes active and draws down an armature to which a pen is attached, and for every contact a mark is made upon the

[1] Bulletino del Vulcanismo Italiano. Periodico geologico ed archeologico per l'osservazione e la storia dei fenomeni endogeni nel suolo d'Italia. Redatto dal Cav. Prof. Michele Stefano de Rossi. Roma, 1878.

paper ribbon. The length of paper corresponding to an hour of time being known, it is easy to determine the instant at which the mark has been made, viz., the instant at which the shock has occurred.

Without any doubt the most interesting article in last year's *Bulletino* is that on the application of the microphone to the study of subterraneous meteorology, by Prof. Michele de Rossi. In 1875 Count C. Mocenigo, of Vicenza, made an observation which was nothing less than the fundamental fact of the microphone, at a time when neither microphone, phonograph, nor micro-tasimeter had been invented. He observed that electric currents indicate perturbations and interruptions in a galvanometer by means of frictions and shocks produced artificially between conductors not in perfect contact ("per effetto soltanto di attriti e di scosse communicate artificialmente ai conduttori posti fra loro in semplice contatto instabile"). He also observed that the same phenomena were produced by natural and unknown causes, when the apparatus had not received any artificial shock.[1] The account which he gave of his observations led Prof. de Rossi to conclude that these unknown perturbations arose from microseismic oscillations of the soil. He communicated his views to Count Mocenigo, who at once commenced to make experiments in the direction indicated, in the midst of which the news of the invention of the microphone in America, was received. Prof. de Rossi at once endeavoured to apply it to the detection of subterranean phenomena, and for this purpose he commenced a series of experiments in the seismic observatory which he has established at Rocca di Papa, one of the Alban Hills about seventeen miles from Rome. A special microphone consisting of a balanced pointed lever lightly touching a plate of silver, was mounted on a stone pedestal, and was placed twenty metres underground, at a distance from habitations and from roads. It was also thoroughly isolated and shut up in a box filled with wool. The instrument was watched during some of the stillest hours of the night, and the same mysterious sounds which Count Mocenigo had recognised were heard by de Rossi, which he considers were incontestably natural and intra-telluric. The sounds were carefully analysed, and were compared with artificially produced sounds. The microseismic sounds were speedily differentiated from other sounds, and their nature was completely confirmed when it was observed that they were often coincident with movements of the seismograph, and that they were of a periodic character. On one occasion, as de Rossi was listening at about half-past three o'clock in the morning the telephone connected with his subterranean microphone emitted sounds like the discharge of musketry, of such loudness that he feared they would awaken a child who slept in the same room, and he therefore disconnected the telephone. A short time afterwards, towards four o'clock, a sensible shock of earthquake occurred, for which the sounds had been the microphonic preparation.

In the beginning of last September Vesuvius showed many signs of an approaching eruption. During the night of the 22nd of that month the mountain produced thundering sounds, and at the same time loud metallic noises were heard in the microphone, more than a hundred miles distant. The microphone was soon afterwards transported to the observatory on Vesuvius, and it was then possible to trace the precise correspondence between the movements of the seismographs and the sounds of the microphone, and moreover to ascertain the seismic value (*il significato sismico*) of the different sounds of the microphone. It was also ascertained that if a watch were connected with the microphone, the noise of the tic-tac heard in the telephone became much louder just before a shock, and gradually less and less loud as the seismic agitation died away. This led Prof. de Rossi to improvise a microphone which he has found very useful for microseismic purposes.



A watch, A, is placed upon a suitable stand, and a thin copper wire, B, connected with the positive pole of a small battery is arranged, as shown in the figure, so that one end of it, furnished with a steel needle, rests lightly upon the smooth silver surface of the watch. The handle of the watch is connected by the wire with the telephone, the other binding screw of which is connected with the negative pole of the battery. Such an arrangement furnishes a very effective microphone, if the degree of contact between the needle and the surface of the watch be carefully regulated.

G. F. Rodwell

[1] "Fenomeni singolari di interferenza fra le correnti elettriche ed i promossi mecanicamente sul legno."—Bassano, 1875.

OUR ASTRONOMICAL COLUMN

The Occultation of Antares, July 28.—The only occultation of a very conspicuous star during the present year which is visible in this country and in fact the only one higher than the second magnitude up to the year 1883, is that of Antares on the evening of July 28. It will take place at a low altitude here. As is well known Antares is a double star, and the effect of the duplicity was shown by observation of the occultation of the star by the moon, before the companion was detected by Mitchel at Cincinnati in July, 1845. The appearance of a comparatively faint star at emersion, suddenly brightening up to the full brilliancy of Antares, had been recorded, and a suspicion of duplicity entertained at least in one instance, some twenty years previous. Interest therefore attaches to the occultation of July 28, and with the view to facilitate the determination of the times of immersion or emersion at any place in this country, we will apply the Littrōw-Woolhouse method of distributing the prediction of the phenomenon. Direct calculations give the following results for Greenwich, Edinburgh, and Dublin; the moon's place is corrected nearly to agree with Newcomb's theory:—

	Greenwich M.T. of Immersion. h. m.	Angle from N. Point. °	Greenwich M.T. of Emersion. h. m.	Angle from N. Point. °
Greenwich.	9 38·11	153·3	10 7·03	200·2
Edinburgh.	9 38·53	166·5	9 49·93	184·9
Dublin ...	9 33·05	161·4	9 50·53	189·0

From which, putting the latitude of the place $= 50° + L$ (L in degrees), and the longitude in minutes of time $= M$ (+ if east, − if west of Greenwich), we find—

$$\text{G.M.T. of Immersion} = \overset{\text{h. m.}}{9\ 36{\cdot}86} + 0{\cdot}841\,L + 0{\cdot}263\,M$$
$$\text{,, Emersion} = 10\ 10{\cdot}74 - 2{\cdot}507\,L + 0{\cdot}462\,M$$

$$\text{Angle from N. Point at Immersion} = 149{\cdot}4° + 2{\cdot}6\,L - 0{\cdot}1\,M$$
$$\text{,, ,, Emersion} = 204{\cdot}2 - 2{\cdot}7\,L + 0{\cdot}2\,M$$

These formulæ give for—

	Immersion. h. m.	Angle. °	*Emersion.* h. m.	Angle. °
Cambridge ...	9 38·7	155	10 5·2	198
Oxford	9 37·0	155	10 4·0	198
Liverpool ...	9 36·5	160	9 56·5	192

Which are Greenwich mean times: the angles are reckoned as is usual in the occultation-predictions of the *Nautical Almanac*, for the inverted image. At Greenwich

the altitude of the star at emersion will be $7\frac{1}{2}°$, and at Edinburgh $5\frac{1}{2}°$.

Suppose, for the sake of an example of the application of the above formulæ, it is desired to know the Greenwich mean times of immersion and emersion of Antares as viewed from Brighton, which place we will assume to be in latitude 50° 50′ and longitude 0m. 32s. west of Greenwich. We have then $L = +0°.83$, and $M = -0.53$m; it will be sufficient to include the second decimal only in the factors for L and M in the formulæ:—

For the *immersion*—

$(+0.83) \times (+0.84) = +0.70$
$(-0.53) \times (+0.26) = -0.14$

The sum $+0.56$m., added to 9h. 36·86m., gives 9h. 37·4m. for G.M.T.

For the *emersion*—

$(+0.83) \times (-2.51) = -2.08$
$(-0.53) \times (+0.46) = -0.24$

The sum -2.32m., added to 10h. 10·74m., gives 10h. 8·4m. for G.M.T.

Similarly the angles will be found to be 152° at immersion and 202° at emersion.

The companion of Antares preceding the principal star nearly on the parallel will emerge several seconds earlier.

The Great Comet of 1874.—Just five years since, as we write, the comet discovered by M. Coggia at the Observatory of Marseilles on April 17, 1874, was beginning to attract general attention as a naked-eye object in the evening sky. The orbit, the determination of which presented some difficulty at first, from the slow motion of the comet, had been ascertained with sufficient precision to enable astronomers to predict its conspicuous appearance in the first half of July, and the track it would follow when, descending below the horizon in Europe, it became a favourably-situated object for the observatories of the other hemisphere. It was observed in Europe until July 16, and about a week later was seen in Australia; observations were continued till October, the last being made at the Argentine Observatory, Cordoba, on the 18th of that month, when it had receded to a distance of 1·94 from the sun and 1·79 from the earth, and was situate about 12° from the south pole of the heavens.

The European observations during three months were found to indicate a sensible, though not very material deviation of the orbit from a parabola, and ellipses were calculated at the time by Tietjen, Schulhof, and Geelmuyden. In a late number of the *Astronomische Nachrichten* are elliptical elements founded by M. Seyboth, of Riga, upon the meridian observations made at Moscow, which appear to possess a very high degree of precision, though they extend over an interval of twenty-six days only. The periods of revolution assigned by these computers are:—

Tietjen	8,965 years.
Schulhof	12,184 ,,
Geelmuyden	10,445 ,,
Seyboth	5,711 ,,

The differences between these periods show that beyond establishing the fact that the comet was moving in an orbit with a period of revolution extending to several thousand years, no reliable approximation to its true length has yet been obtained, but the additional three months' observations in the southern hemisphere have not hitherto been brought to bear upon the determination of the elements. The last Cordoba observations give the following final position:—

1874, October 18, at 14h. 46m. 58s. G.M.T.

	° ′ ″
Apparent Right Ascension	99 46 27·0
,, Declination	−77 42 36·6

If we compare the elements of Geelmuyden and Seyboth with this observation, taking aberration into account, we find the following differences:—

	Error in R.A. ″	Error in Decl. ″
Geelmuyden	+ 31	+ 65
Seyboth	+ 59	+ 99

so that while, as tested by this single observation, the longer period of revolution appears to have the advantage, it is sufficiently evident that ellipses with divergent periods may eventually be found to represent the observations with almost equal precision, or in other words the length of the revolution will remain open to considerable uncertainty. If the deviation of the form of the orbit from the parabola, which satisfies the motions of the majority of comets be due to planetary attraction, we might look to Venus as the agent, since at the descending node the comet in 1874 approached the orbit of that planet within 300,000 miles (0·00325 of the earth's mean distance); the opposite node falls at a radius-vector of 11·65. The aphelion distance, according to Geelmuyden's calculation would be 955·0, or the comet would have travelled to these parts of space from a distance exceeding by more than thirty times the mean distance of Neptune.

GEOGRAPHICAL NOTES

The Abbé Debaize, who by previous accounts was at Igonda on March 20, seven days' journey from Ujiji, has written under date of April 2 from the latter place to the director of the Paris Observatory and others, giving a brief sketch of his immediate plans. He proposes to take all his porters and merchandise by water to the Uzighé country at the north end of Lake Tanganyika, and to form a depôt there, which he will leave in charge of some of his best men; he will then establish a second depôt at the mouth of the Aruwimi, the great northern tributary of the Congo. Afterwards, starting in light marching order, he hopes to be able to explore the western slopes of the Blue Mountains, the countries situated between the southern end of Albert Nyanza and Lake Tanganyika, and especially Unyambongu, Mpororo, and Ruanda. He will then return to his depôt in Uzighé, whence he will send home an account of his discoveries, as well as a statement of his future plans.

An interesting and extremely well written pamphlet has just appeared in the "Sammlung gemeinverständlicher wissenschaftlicher Vorträge," edited by Prof. Virchow and Herr von Holtzendorff. Its title is "Die Tiefsee und ihre Boden und Temperatur Verhältnisse," its author Dr. Georg von Boguslawski, the well-known editor of the *Annalen der Hydrographie* at the Imperial Admiralty of Berlin. The writer first gives a clear and concise account of all expeditions sent out by various countries for the investigation of the depths of the sea, particularly those of the *Gazelle*, the *Challenger*, and the *Tuscarora*. He then enters at greater length upon a discussion of the results obtained hitherto, treating first of the depths themselves, then of the outlines and physical condition of the sea-bottom, and finally of the distribution of temperatures and the inter-oceanic currents, with their causes and effects. Our space does not permit us to enter into details at greater length, suffice it to say that the little work is a welcome and valuable addition to scientific literature.

The Geographical Department of the Japanese Government, which is displaying considerable activity in many directions, has commenced the publication in sheets of a large plan of the city of Yedo, showing the various divisions, streets, bridges, &c., and giving the names in Japanese and Roman characters.

Under the title of "Voyage d'Exploration dans l'Intérieur des Guyanes," the *Tour du Monde* has commenced the publication of Dr. Jules Crevaux' account of his journey in 1876-7 through French Guiana and across the Tumac Humac range to the Amazons. The illustrations are very interesting and well executed, and there is also a sketch map of the region.

THE *Annalen der Hydrographie*, Heft v., contains an important article on the Movement of Water in Rivers, based on river observations at various depths of water, made at the lightship station on the Genius Bank, in the Jade, from October 17 to December 10, 1878.

M. GUSTAVE MOYNIER, as Director, and M. Ch. Faure, as Editor, announce the publication of a new geographical journal—*L'Afrique*—entirely devoted to Africa. It is proposed to embrace in it the gist of all that is important published anywhere relating to the continent with which the journal deals. It will be published monthly by M. Jules Sandoz, Geneva, the size being sixteen pages octavo.

AN *Annuaire des Sociétés de Géographie* will shortly be published in Paris.

WE learn from *Vanity Fair* that a party, of which Lady Florence Dixie was the only lady, has just returned from South America, where they "crossed many hundreds of miles of the wild and unexplored pampas of Patagonia, penetrating amidst the Cordilleras into splendid scenes hitherto unexplored and unseen by man."

THE *Bulletins* of a number of foreign societies are to hand The new number of the *Bulletin* of the Lyons Geographical Society contains, besides the annual report, the conclusion of M. Luciano Cordeiro's chapters on the first explorations of Central Africa and the Portuguese doctrine of African hydrography in the fifteenth century, and the first part of an essay on Central Asia, by Col. Debize. In this number he deals with Eastern Turkestan, illustrating his remarks with a sketch map of North-Western China and Kashgaria.—The last number of the *Bulletin* of the Société de Géographie Commerciale of Bordeaux contains a second paper on the subject of the commercial exploration of Ferlo, an almost wholly unknown region of Senegambia.—The May number of the *Bolletino* of the Italian Geographical Society contains a learned and able lecture by Prof. Marinelli, on Scientific Geography, in which he traces the progress of this department, and shows how comprehensive and important it is.—The last number of the *Bulletin* of the American Geographical Society (No. 2 of 1879) contains a paper by Major A. G. Constable on Afghanistan. Major Constable served in the English army in the former Afghan war.—The May number of the *Bulletin* of the Paris Geographical Society contains a full report of the proceedings at the recent Cook Centenary in Paris, including a descriptive catalogue, by Dr. Hamy, of the articles exhibited during the celebration, and the cartography and bibliography of Cook's voyages, by Mr. James Jackson. An accompanying map shows the routes followed by the English navigator in his various voyages.

NOTES

FOR the fine plate of tubes in this week's number, illustrating the paper by Messrs. De La Rue and Müller, as well as for the numerous woodcuts, we are indebted to the liberality of Dr. De La Rue.

IT is gratifying to find foreign governments and societies so ready to show their appreciation of our eminent scientific workers. Last week we announced the election of Prof. Huxley as a Corresponding Member of the Paris Academy of Sciences, and now we have to chronicle a double honour just received by Prof. Stokes of Cambridge: the Emperor of Germany has conferred upon him the Order "Pour le Mérite," and the Paris Academy have elected him a Corresponding Member in the section of Physics in place of the late Prof. Ångström.

DR. DONDERS has been elected in the section of Medicine and Surgery in the same Academy, to succeed the late Prof. Ehrmann.

THE candidates whose names we have already given were elected Fellows at last Thursday's meeting of the Royal Society.

PROF. SIR C. WYVILLE THOMSON was last week compelled, from sudden indisposition, to relinquish his course of lectures at the University of Edinburgh. We are glad to be able to announce that he is now completely recovered. His medical attendants, however, deem it prudent that he should abstain from lecturing again this session. His large class of between 400 and 500 students has accordingly been entrusted to Prof. Alleyne Nicholson, of St. Andrews, who will conduct it during the remainder of the session. Though dissuaded from undertaking the heavy duties of his college work, Sir Wyville, we hope, will find strength to resume his labours amid the *Challenger* materials, so that this great work, for which the world is very patiently waiting, may suffer no serious delay.

PROF. WURTZ, the eminent French chemist, has been appointed a Member of the Council of the Legion of Honour.

THE arrangements for the annual meetings of the principal foreign associations are announced. The German Anthropological Society holds its yearly meeting at Strassburg on August 11, 12, and 13, and the fifty-second meeting of the German Association of Naturalists and Physicians will be held at Baden-Baden from September 18 to 24. The French Association for the Advancement of Science will hold its eighth session at Montpellier, commencing on August 28. The president is M. Bardoux, late Minister of Public Instruction. Applications are to be addressed to 76, Rue de Rennes, Paris. The American Association meets this year at Saratoga, on August 27, the President being Mr. George F. Barker, of Philadelphia.

EARTHQUAKES would seem to be plentiful and wide-spread at present. A Reuter's telegram, of date Messina, June 17, states that continual shocks of earthquake, attributed to the volcanic action of Mount Etna, have occurred in the neighbourhood of Santa Venere and Guardia, causing serious damage and considerable loss of life. Vesuvius is stated to be showing signs of activity. A distinct shock of earthquake is reported to have been felt on Monday at Tobermory, and other places in Mull, in the Hebrides. The shock passed from north-east to south-west. On the 7th inst. an earthquake of short duration was observed at Versailles at 10·55 P.M. There was a severe shock of earthquake in Costa Rica on the night of May 29. The cathedral and many of the principal buildings of San José were shattered, and much damage was done in other parts of the republic.

DR. J. C. DRAPER is at present in this country. He has been extending his researches on oxygen in the sun (see NATURE, vol. xix. p. 352), and has read papers on the subject at the Astronomical and Physical Societies.

WE regret to announce the death of Dr. Karl Neubauer, the eminent German chemist. Dr. Neubauer died on the night of June 1-2 at Wiesbaden, where for many years he had been working in the laboratory of Dr. Fresenius. The death is also announced of Dr. Justus Ulrich, Professor of Mathematics at Göttingen University, who died on May 30.

THE Committee on Electric Lighting, recently appointed by the House of Commons, have finished hearing evidence, and issued their Report, which is in substance as follows:—"That sufficient progress has been made with electricity as a means of lighting to encourage the belief that it has an important future before it, and not only for illuminating purposes, but as a source of power which may be wisely distributed and applied to mechanical purposes. The committee are of opinion that the electric light, even in its present state of development, can be advantageously used in large areas, open or inclosed, such as large halls, squares, or railway stations; but they do not think it has been so far matured as to be able to compete with gas for

domestic purposes. They therefore do not recommend any legislation for applying the light to private purposes on the strength of its being practicable for large spaces and buildings, but they do recommend that no legislative restrictions shall be allowed to impede its further development. As to granting authority for adopting the electric light, the committee think there is already in existence sufficient power for applying it to open spaces and large centres; and, mentioning the diversity of views among the witnesses as to whether or not municipal bodies have power under existing statutes to break up streets for the purpose of laying electric light wires, they say that if such power does not exist it should be granted under proper regulations. They consider, however, that the time is not yet ripe for allowing private companies to break up streets in order to supply the electric light, but they advise that municipal authorities should receive all possible help for public lighting by electricity, and that the Legislature should be willing to give all reasonable facilities for extending the use of the electric light where proper demand for it arises. They consider further that for lighthouse purposes the electric light has established itself, but they have not been able to satisfy themselves from the evidence that electric lighting is economical as compared with gas.

THE success of the Jablochkoff lights at the Palais de l'Industrie is nightly increasing. The number of visitors exceeds 6,000 nightly, exclusive of press men, artists, and bearers of free tickets. The *salons* are rather more crowded than in daylight. No extinction at all has been noticed since the first night. The change of candles is effected by keys worked from the engine-house, and takes less than a second for each series of lamps. Several places of public entertainment in Paris are adopting the Jablochkoff light principally to avoid the heat which results from burning gas, and is so obnoxious in summer time.

As an illustration of the combination of science and commerce we may mention a new idea that has lately been carried out by a Swiss firm of chocolate-makers. We are unable to say whether the chocolate *bon-bons* have any peculiar merit in themselves, but the attraction lies in the manner of packing, the sweetmeats being put up in boxes containing two layers of small packets put up in very ornamental wrappers with coloured designs, in series representing the various branches of natural history, such as birds, butterflies, fishes, fruits, flowers, and even palæontology and geography. Each box, containing about twenty small packets of chocolate, is accompanied with a concise descriptive treatise in French written by a competent naturalist. That on birds is thus described:—"After a pleasant general introduction on the utility and charming attraction of birds, and the necessity for the protection and preservation of many, a brief sketch is given of their properties of flight, structure, organs of sense, sight, smell, and voice, respiration, nests, eggs, and incubation, moulting, geographical distribution, migration, utility to man, and general classification. Instructions are also given for preparing and mounting bird-skins, and scientific descriptions are furnished of those birds chosen for illustration either for their beauty or brilliant plumage." A similar plan to the above is adopted in other branches of natural history.

HARTLEBEN of Vienna announces the publication of an Illustrated History of Writing, a popular account of the origin of writing, of speech, and of numbers, as well as the systems of writing of all peoples. The author is Herr Karl Faulmann. The work will be illustrated with numerous coloured plates as well as woodcuts.

THE *Patriot* of Angers relates that on June 10 an immense number of butterflies were observed flying above a part of the city called Le Mail. They were travelling at a little distance from the earth, and inconveniencing persons walking in the streets. The same phenomenon was observed in Alsace, at Bisheim, on the 8th. The Bisheim butterflies were so numerous, according to the *Journal d'Alsace*, that the light of day was obscured. Their colour was red, in places tinged with grey. On the 7th the commune of Wetzikon, in the canton of Zurich, was invaded by an immense swarm of butterflies a kilometre wide, and so long that the procession took two hours to pass. They flew from two to ten metres above the ground, and went off in a north-westerly direction. Swarms of grasshoppers have recently appeared in Armenia. News from Elisahetpol states that both the banks of the River Kur were completely covered with the insects, as far as Terter on the one bank, and as far as Akstafa on the other. All vegetation is devastated.

The *North German Gazette* states that a woman in the neighbourhood of Düsseldorf, who had been bitten by a mad dog, has been cured by Dr. Offenberg, by an injection under the skin of a dose of twenty centigrammes of curare.

THE village of Mariaweiler near Düren (Rhenish Prussia) proves to be a great field of *débris* of a Roman colony. A Roman villa has just been excavated there so that most of the apartments could be measured. An inscription in one of the rooms has not yet been deciphered. The Roman coins found at the place date down to the fourth century.

FOSSIL remains of a mastodont have just been found in Vienna on the Ottakringer Strasse. Prof. von Hochstetter himself undertook the excavation of the remains. With the exception of the jaw and teeth all the bones found are much decomposed, and it will be very difficult to preserve them.

A GENEVA correspondent writes that a meteor of remarkable brightness and size was seen on June 7, about 10 P.M., in the neighbourhood of that city. It was also seen at Neuchâtel, Zug, Milan, and over its entire course its path was sinuous, presenting a strange zig-zag form. Some who saw it speak of it as having the appearance of the full moon, giving out an iridescent or greenish light. Its path was from north-east to south-west. The meteor, according to the *Times* Geneva correspondent, was seen in several other parts of the Confederation and at St. Vittore Olona, in Lombardy. Four minutes after it finally disappeared, he states, there was heard a loud report, resembling a volley of artillery. A similar report was heard in the Valaisian Alps, and almost at the same time, according to the *Gazette de Lausanne*, a shower of aërolites fell into Lake Lugano, near Melide, causing violent undulations, and nearly overturning the boats of several fishermen who were returning to port.

ON Friday last a first trial was made at Woolwich of the new 100-ton gun. The shot with which it was loaded weighed 2,010 lbs. The gun was fitted with a gas check. Its diameter was very little less than that of the bore, which has a calibre of 17¾ inches, increasing to 19¾ inches in the powder chamber. The thickness of the metal at the muzzle is about 5 inches only, but at the breech-end the chamber is surrounded with a wall of iron 2 feet 5 inch through, making the maximum diameter 6 feet 6 inches. The gun is 36 feet in length, of which the bore occupies 33 feet, and the total length of gun and carriage when run out for firing is 44 feet. The cartridge, consisting of 440 lbs. of cube powder, strongly bound in canvas and stiffened by wooden bands, was rammed home, occupying 5 feet of the bore, and then followed the projectile, the length of which was 2 feet 8 inches. The gun was fired by electricity from the instrument-room, and recoiled a considerable way up the platform, but suffered no damage either to itself or the carriage. The screens registered a velocity of 1,590 feet per second, but the projectile was found to have broken up, which may have affected the result.

THE Mayor of Liverpool has given to the Council of the Iron and Steel Institute an invitation to visit that town in September, and a deputation from the Council of the Institute waited upon

the Mayor at the Buckingham Palace Hotel on Saturday, when they discussed with him the preliminary arrangements and provisionally fixed September 24, 25, and 26 for the meeting, which will be the first held by the Institute in that town.

IN the annual report of the Deputy Master of the Mint, issued last week, we find some remarks on several points of scientific interest more or less intimately connected with the work of minting. Among these may be mentioned the adjustment of blanks by electrolytic agency, to which attention had been directed in former years. The process, originally advocated by Mr. Roberts, the chemist of the Mint, has already been employed on a large scale in the Indian Mint. The question of the change in the density of a metal by annealing is one of some importance in the operations of minting. The experiments commenced in 1877 showed that the effect of even moderate temperatures was appreciable, and the results of their continuation are given by Mr. Roberts. In connection with this subject, Mr. Fremantle remarks that it is interesting to turn to such experiments of M. Tresca on the flow of solids as have special reference to mint work, and to those which have been undertaken in the English Mint on the flow of molten metals through capillary tubes. It is hoped that the latter may ultimately throw light on the phenomenon of liquation.

THE *conversazione* of the Society of Arts will be held in the South Kensington Museum on June 25.

THE members of the International Telegraphic Conference were entertained at dinner on Tuesday night, and last night a *conversazione* was held in connection with the Conference. The labours of the Conference have been chiefly administrative and financial.

WE learn from the *Colonies and India* that rich deposits of gold have been discovered in various parts of Nova Scotia, where its existence has hitherto been hardly suspected. The most important discovery made has been near Bannockburn, in the township of Madoc, where a large nugget of gold of fine quality was recently found, and an extensive gold field is being opened out. Coal and iron are also plentiful in the province.

THE additions to the Zoological Society's Gardens during the past week include an Indian Antelope (*Antilope cervicapra*) from India, presented by the Hon. A Greville, 60th Rifles; a White-whiskered Paradoxure (*Paradoxurus leucomystax*) from the East Indies, presented by Mr. Carl Bock; two Common Paradoxures (*Paradoxurus typus*) from India, presented by Mr. G. Bradbury; a Common Magpie (*Pica caudata*), British Isles, presented by Mr. J. Loraine Baldwin, F.Z.S.; a Laughing Kingfisher (*Dacelo gigantea*) from Australia, presented by Mr. E. Hawkins; a Tuberculated Lizard (*Iguana tuberculata*) from the West Indies, presented by Dr. A. Stradling; a Caspian Ouaran (*Psammosaurus caspicus*) from Persia, presented by Commander J. Pratt, s.s. *Java*; a West African Python (*Python sebæ*) from West Africa, presented by Mr. G. H. Garrett; five Climbing Anabas (*Anabas scandens*) from India, presented by Mr. A. F. Dobson; a Tamandua Anteater (*Tamandua tetradactyla*), a Sun Bittern (*Eurypyga helias*) from South America, a Black-eared Marmoset (*Hapale penicillata*), a Brazilian Cariama (*Cariama cristata*) from South-east Brazil; a Crested Screamer (*Chauna chevaria*) from Buenos Ayres, a Daubenton's Curassow (*Crax daubentoni*) from Venezuela, a Negro Tamarin (*Midas ursulus*) from Guiana, a Spotted-billed Toucanet (*Selenidera maculirostris*), three Violet Tanagers (*Euphonia violacea*), two Saffron Finches (*Sycalis flaveola*), a Pileated Finch (*Coryphospingus pileatus*) from Brazil, a Great American Egret (*Andea egretta*), a Red and Yellow Macaw (*Ara chloroptera*) from South America, deposited; a Black Hornbill (*Buceros atratus*) from West Africa, a Green-winged Trumpeter (*Psophia viridis*) from Brazil, a Common Crowned Pigeon (*Goura coronata*) from New Guinea, two Orinoco Geese (*Chenalopex jubata*) from South America, six Melodious Finches (*Phonipara canora*) from Cuba, purchased; two Geoffroy's Doves (*Peristera geoffroii*), two Yellow-legged Herring Gulls (*Larus leucophæus*) bred in the Gardens.

THE RECENT HONORARY DEGREES AT CAMBRIDGE

IT may interest our readers to see the terms in which the Public Orator of Cambridge University spoke of the eminent men of science on whom the degree of LL.D. was conferred on June 10, as we announced last week. Mr. Sandys spoke as follows of Sir William R. Grove:—

Iuris initium a natura esse ductum auctore Tullio accepimus; iuris peritiam summam cum intima rerum naturae cognitione esse consentaneam, non modo Baconis nostri exemplo confirmatum est, sed huius quoque iudicis auctoritate defenditur. Magnum profecto rerum naturae amorem testatur oratio illa, qua tredecim abhinc annos societatis Britannicae scientiarum finibus proferendis annui praesidis munus auspicatus, in universa rerum natura ordinem quendam serie perpetua continuatum inesse docebat; testatur oratio illa altera plusquam triginta abhinc annos primum edita, qua primus indicavit lucem, calorem, vim electricam, vim magneticam, mutuam rerum quae dicitur affinitatem, ipsum denique motum, omnes alium ex alio posse generari, omnes necessitudine quadam inter se aptos et connexos esse, "ostendens" (ut Lucreti verbis utar)

> corpuscula materiai
> ex infinito summam rerum usque tenere
> undique protelo plagarum continuato.

Quod si ipse continuo tenore totam tanti ingeni vim rerum naturae cognoscendae intendisset; ille profecto qui luci electricae novum splendorem addidit, talium rerum obscuritati etiam maiorem lucem attulisset. Ceterum ille qui non modo legum scientiam sed scientiarum quoque leges optime interpretatus est, iure optimo legum doctor hodie creabitur; duplicis palmae laudem meritus, vestro omnium plausu iure excipietur Wilelmus Robertus Grove.

In introducing Dr. William Spottiswoode the Public Orator said:—

Societatis Britannicae scientiarum finibus proferendis praeses ille quem Regiae quoque Societatis praesidem hodie salutamus, fines quam amplos mathematicorum regno assignaverit, meministis omnes qui anno proximo orationem illam Dubliniensem audivistis. Imperium neque temporis neque spatii finibus terminatum illis dedit quos nonnunquam invat quasi oceani infiniti propter litora calculos numerare, nonnunquam in purum illud caelum, regionem illam inexplicabilem evolare, ubi spatium multiplex extenditur, ubi nodi tantum abest ut solvi ut ne necti quidem possint. Ipse ne Europae quidem philosophorum finibus contentus, Indorum quoque doctrinam mathematicam et antiquam linguam sacram exploravit; Asiae et Europae confinia bis lustravit, lustrata litteris mandavit. Populi in usum, ordine quam lucido lucis et coloris leges ipse illustravit; quot aliorum libros e prelo suo regio in lucem emisit, et sua et nostra cum Academia privilegiorum communium iure adhuc aliquatenus coniunctus; quanta denique liberalitate, et ministrorum suorum et populi universi liberaliter educandorum causa, pro virili parte laboravit. Ut viro integerrimo, titulis plurimis aliunde cumulato, nostri quoque tituli mantissa accedat, duco ad vos Wilelmum Spottiswoode.

Of Prof. H. J. S. Smith he said:—

Pariter iniquum esse existimavit Aristoteles ab oratore rerum omnium rationes accuratas exigere, atque mathematicum ad persuadendum apposite dicentem tolerare. Atqui ipse exemplar egregium μαθηματικοῦ πιθανολογοῦντος libenter admiratus esset, si in senatu Oxoniensium flumen orationis aureum fundentem hunc geometriae professorem audire potuisset, qui nomine duplici, et linguarum antiquarum et scientiarum mathematicarum peritia, cathedra illa dignus est quam Savilius ille, et Chrysostomi editor et interpres Euclidis, primus occupavit, occupatam annuo reditu in perpetuum ornavit. Tertii quidem ordinis linearum enumerationem Newtonus ille noster olim Latine conscripsit, hic autem, quarti ordinis lineis eadem lingua descriptis, e certamine toti Europae ab Academia Berolinensi proposito, duplicis palmæ particeps discessit. Quanta igitur spe et expectatione libros illos de recentiore quae dicitur geometria, de subtilioribus numerorum

proprietatibus, plusquam Horatianum annorum numerum huius intra scrinia clausos, iamdudum flagitamus; quos, nti par est omnibus numeris absolutos, aliquando prodituros esse speramus. Interim in negotiis Academicis singulari urbanitate diu versatus, nunc non modo collegio augurum-Britannicorum qui caeli praesagia observant praesidet, sed septemviris quoque Academiae Oxoniensi legibus conscribendis ascriptus est. Academiae illius pulcherrimae inter decora diu numeretur, diu Platonis praecepto obsecutus videat ut *οἱ ἐν τῇ καλλιπόλει* geometriam nequaquam neglegant. Duco ad vos Henricum Stephen Smith.

Of Prof. Huxley the Orator spoke thus:—

Academi inter silvas qui verum quaerunt, non modo ipsi veritatis lumine vitam hanc umbratilem illustrare conantur, sed illustrissimum quemque veritatis investigatorem aliunde delatum ea qua par est comitate excipiunt. Adest vir cui in veritate exploranda ampla sane provincia contigit, qui sive in animantium sive in arborum et herbarum genere quicquid vivit investigat, ipsum illud vivere quid sit, quali ex origine natum sit; qui exquirit quae cognationis necessitudo, inter priores illas viventium species et has quae etiam nunc supersunt, intercedat. Olim in oceano Australi, ubi rectis "oculis monstra natantia" vidit, victoriam prope primam, velut alter Perseus, a Medusa reportavit; varias deinceps animantium formas quasi ab ipsa Gorgone in saxum versas sagacitate singulari explicavit; vitae denique universae explorandae vitam suam totam dedicavit. Physicorum inter principes diu honoratus, idem (ut verbum mutuemur a Cartesio illo cuius laudes ipse in hac urbe quondam praedicavit) etiam "metaphysica" honore debito prosecutus est. Illum demum liberaliter educatum esse existimat qui cum ceteris animi et corporis dotibus instructus sit, tum praesertim quicquid turpe sit oderit, quicquid sive in arte sive in rerum natura pulchrum sit diligat; neque tamen ipse (ut ait Aristoteles) "animalium parum pulchrorum contemplationem fastidio puerili reformidat," sed in perpetua animantium serie hominis vestigia perscrutari conatus, satis ampla liberalitate in universa rerum natura "humani nihil a se alienum putat." Duco ad vos virum intrepidum, facundum, propositi tenacem, Thomam Henricum Huxley.

Finally, among the scientific men who were honoured with the degree was Mr. H. C. Sorby, of whom the Public Orator said:—

Quam magna est rerum natura, in magnis quam immensa, in minimis quam magna. Quam multa miracula, antiquis ignota, illis nuper ostendit qui minuta curiositate arcana illa quae oculorum aciem fugiunt, instrumentorum novorum auxilio perscrutantur. Hic autem ille est qui, et terrestrium et de caelo delapsorum lapidum investigandis elementis primis, primus inter Britannos talium instrumentorum usum accommodavit. Nuper societatis geologicae praeses electus, annorum triginta labores oratione cumulavit in qua vere marmoreum sibi monumentum exegit. Illud vero acutissimum quod crystallis etiam minutissimis exploratis in quibus (ut fit) pars altera est aquae plena, altera aëris quoque vacua, olim indicavit qua potissimum caloris temperie inclusa illa aqua totum illud vacuum implere, quo potissimum rerum statu saxum illud, quondam ignibus prorsus liquidum, primum durescere potuisset. Scilicet crystallum illud (ut Claudianus ait)

> non potuit toto mentiri corpore gemmam;
> sed medio mansit proditor orbe latex.
> auctus honos; liquidi crescunt miracula saxi
> et conservatae plus meruistis aquae.

Suo phaselo vectus quot maria mox lustrabit, in terra iam pridem unum saltem Argonautarum, qui terram oculis penetrabat, eatenus aemulatus, quod in intima saxorum materia perspicienda, ipse oculo potuit "quantum contendere Lynceus." Duco ad vos Henricum Clifton Sorby.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Clothworkers' Company have voted 3,500*l*., over and above 10,000*l*. previously voted, to cover the complete cost of the site, building, furnishing, and fitting with all necessary appliances the textile industries and dyeing instruction departments of the Yorkshire College, Leeds, and they have further agreed to maintain the building and its operations in full effect without extraneous or adventitious aid, for a period of five years as from January 1 next, at a cost of 1,200*l*. per annum. This increased annual subvention has been necessitated by the addition of instruction in dyeing and applied chemistry connected with the finishing of textile fabrics. The new buildings will be completed about October next.

THE following awards for proficiency in Natural Science have been made at St. John's College, Cambridge:—Foundation Scholarships to W. A. Forbes, Fleming, Hart; a Proper Sizarship to Samways; Exhibitions to Lister, Samways, Stuart (already scholar), and Weldon. Forbes received also a Wright's Prize and augmentation of the year's emoluments to 100*l*. The Open Exhibition was awarded at Easter to Edmunds (University College, London), and a Second Exhibition to T. Roberts (University College, Aberystwith).

THE amended report of the Cambridge Botanic Garden Syndicate has been confirmed so far as relates to the stipend of the curator, which is fixed at 150*l*., he not to take private pupils, and to be allowed 25*l*. per annum for the rent of a house until one is provided in the garden.

PROBABLY the oldest teacher in existence is the venerable M. Chevreul. This eminent chemist, who is about ninety years of age, has been advertised as lecturer on chemistry in the Paris Museum. The first part of his lectures will be devoted to the subject of contrast of colours. M. Chevreul enjoys excellent health, and exhibits admirable bodily as well as mental activity.

THE fourth centenary of the foundation of the University of Copenhagen was celebrated in that city on the 4th inst. No less than 4,000 people took part in the celebration, including the Royal family and all the highest civic and military authorities. The festive address was delivered by the Rector Magnificus, Dr. Madvig.

SCIENTIFIC SERIALS

Bulletin de l'Académie Royale de Belgique, No. 4.—Besides communications on the blood of the lobster (Fredericq), displacement of spectral lines of stars (Spee), and perpetual motion (Plateau), we have here a paper by M. Fredericq on the theory of respiratory innervation; he is led to regard the spinal cord as containing an inspiratory centre and an expiratory centre, chloral acting to paralyse the former.—M. van der Mensbrugghe contributes a paper on new applications of the potential energy of liquid surfaces, dealing with the principal cause of loss of charge by water-jets, origin of the energy of motion acquired by waves of the sea, cause of production of bars at the mouths of certain rivers, and origin of the force of the Gulf Stream.—M. De Selys Longchamps communicates the additions to the synopsis of the Calopterygines.

Atti della R. Accademia dei Lincei, April.—We note here the following:—Influence of boric acid on acetic fermentation, by Prof. Herzen.—Distribution of subsoil water in the Agro Romano, and its influence in production of malaria, by S. Tommasi-Crudeli.—On giant-cauldrons, by S. Botti.—Geological studies on the northern Graian Alps, Italian side, by Prof. Baretti.—On the supposed identity of columbine with limonine, by SS. Paterno and Oglialoro.—On the kinzigite of Calabria, by Prof. Lovisato.—New rock-specimens from Calabria, and remarks on the serpentine formation of that region, by the same.—On the geodetic line; third general problem; analysis of spheroidal triangles, by Dr. Wurterberg.—On observations of the horizontal diameter of the sun, made at the Royal Observatory of the Campidoglio in 1878, by S. Respighi.—Catalogue of algæ gathered during the cruise of the cutter *Violante*, and especially in some small islands of the Mediterranean, by S. Piccone.—On the motion of a simple pendulum in a railway carriage, by S. di Saint-Robert.—On the difficulty of obtaining sulphuric acid perfectly free from arsenic, on the mode of obtaining it, and on some things relating to arsenic, by S. Selmi.—On the miocene strata of Siena, and considerations on the upper miocene.—On the crystalline form of anglesite of Sardinia, by S. Sella.—Obituary notice of Volpicelli, with list of published works.

Journal of the Franklin Institute, May.—Limit of efficiency in heat-engines, by Prof. Thurston.—The driving-power of leathern belts, by Mr. Cooper.—On the initial effect of the earth's rotation on the free pendulum, by Prof. Tobin.—On the measurement of tidal heights, by Mr. d'Auria.

THE *Verhandlungen des Vereins für naturwissenschaftliche Unterhaltung zu Hamburg* (vol. iii. 1876) contain, amongst other less important ones, the following papers:—On the manners and customs of the Hamrán tribe, by M. Eckardt.—On the

myths and songs from the South Pacific, by Dr. C. Crüger.—On the metamorphosis of amphibia, by Dr. J. W. Spengel.—Some diagnoses of new Heteromera, by Dr. Haag-Rutenberg.—Descriptions of some new butterflies from the Philippine Islands, by G. Semper.—On the species of the butterfly-genus *Zethera*, by the same.—On butterflies from Wladiwostock and from the Gaboon River, by Dr. C. Crüger.—On dimorphism and variations of some North American butterflies, by J. Boll.—On the metamorphosis of *Sepedon*, by G. Gercke.—On *Helix alonensis*, Fer., by H. Strebel.—Note on the geography of molluscs, by J. D. E. Schmeltz.—On the miocene formation of Reinbeck and its mollnsc fauna, by Carl Gottsche.—On the geognostical conditions of the neighbourhood of Kiel, by Dr. A. Braasch.—On petroleum springs, by S. B. Guttentag.—Ornithological notes on the fauna of the Lower Elbe, by F. Böckmann.—On the lepidoptera fauna of the same district, by L. Graeser and A. Sauber.

THE *Jahrbuch der kais. kön. geologischen Reichsanstalt zu Wien* (1879, part 1, January—March) contains the following papers:—On the metalliferous deep eruptions of Zinnwald-Altenberg (on the Saxon-Bohemian frontier), and on the tin-mining in that district, by E. Reger (with plates).—On the tertiary formation of Waldböckelheim (near Kreuznach, Rhenish Prussia) and its *polyparium* fauna, by Dr. A. von Klipstein.—On the geology of the Rhodope Mountain chain, south and south-east of Tatar Pazardžik, by Anton Pelz.—On the jurassic limestone rock *débris* in the diluvial formation of Moravia and Galicia, by Anton Rzehak.—Geological sketch of the highest part of the Sierra Nevada in Spain, by Dr. Richard von Drasche. This sketch is highly interesting and elaborate; it is accompanied by several plates and numerous illustrations.—On some limestones containing *orbitoida* and nummulites from the so-called "Goldberg" near Kirchberg, on the Wechsel Mountain (Austria), by Franz Toula.—Researches on the age of the North-Bohemian brown-coal (lignite) formation, by D. Stur.—On the productivity and the geotectonic conditions of the Caspian naphtha districts, by Hermann Abich.

THE *Moniteur Scientifique* (Paris: June, 1879), amongst numerous papers, which are noticed by us elsewhere, contains the following papers:—On the influence which a change of temperature exercises upon the deviation which inverted sugar produces upon polarised light, by Paul Casamajor.—On the acceleration in the tanning of hides by means of phosphoric acid, by E. Ador.—On "antichlore" (hyposulphite of soda), by M. G. Lunge.—On ozokerite and ceresine from Galicia, by Dr. J. Grabowsky.—Researches on the root of *Alstonia*, by O. Hesse.—On the use of anhydrous chloride of calcium as a conservative for steam-boilers, by M. Burstyn.

THE *Journal of the Russian Physico-chemical Society* (vol. xi. No. 5) contains the following papers:—On the amines containing tertiary alcoholic radicals, by M. W. Rudneff.—On tertiary isosulphocyanates, by the same.—On the polarisation of electrodes, by M. A. Sokoloff.

THE *Rivista Scientifico Industriale* (Nos. 8 and 9, 1879).—From these numbers we note the following papers:—On a direct application of the free fall of bodies, by G. Mocenigo.—On the atmospheric whirlstorm of February 24—25, by Prof. L. Respighi.—On a telephonic microphone for demonstration at schools, by Prof. G. Cantoni.—On a new method to determine the specific gravity of liquids, by Prof. M. Cagnassi.—On some new phenomena connected with the plasticity of solids, by Prof. C. Marangoni.—On some phenomena due to the viscosity of liquids, by the same.—On sand showers, by Prof. Tacchini.—On a telephotographic apparatus with a single wire, by Prof. C. Perossino.—On the magnetic properties developed in nickel and cobalt by induction compared to those of iron, by Prof. T. Martini.—On a new steelyard-densimeter, by Dr. C. Chistoni.

THE *Revue Internationale des Sciences* (May, 1879) contains the following papers:—On the glacial epoch, by Th. Kjerulf.—On the reciprocal assistance which descriptive and geographical zoology may render to each other, by M. Lataste.—On the colouring-matter of urine, by M. Masson.—On the mechanical theory of the position of leaves, by Dr. Schwendener.—The number, besides the above, contains an interesting account of the organisation of medical instruction at Lyons, as well as an excellent review by M. C. Issaurat of Dr. F. Isnard's new book entitled "Spiritualisme et Matérialisme." This serial has considerably improved since it appears only in monthly parts instead of in weekly numbers as it did up to the beginning of 1879.

Mittheilungen der naturforschenden Gesellschaft in Bern (Nos. 923-936, 1877).—From this part we note the following papers of interest:—Botanical and geological notes from a tour in the province of Reggio in Calabria, by J. Coaz.—On the most important conditions of shape in the leaf of phanerogamic plants, by Herr Fankhauser.—On the principal laws of growth in Florideæ, by the same.—On the formation of the stem in *Lepas anatifera*, by Dr. Lang.—On some luminous bacteria, by Dr. M. Pertz.—Various notes on electrical instruments, by Herr Rothen.—On the soda efflorescences in the Ganges districts, by Prof. Schwarzenbach.—On the geology of Kerguelen's Land, by Prof. Th. Studer.—On deep-water siphonophora, by the same.—On the coloration of the retina, by Dr. A. Valentin.—On some preparations preventing fermentation, and their applicability for the conservation of food.

THE *Giornale di Scienze naturali ed economiche* (Palermo, 1878, vol. xiii.) contains the following papers:—On the cornea of osseous fishes; contribution to the morphology of the eye of vertebrates, by Dr. C. Emery.—On the solar spots observed at Palermo in 1877 and the first three months of 1878, and on the frequency of the vapours of iron and magnesium at the solar surface, by P. Tacchini.—Enumeration and synonyms of the conchyfera of the Mediterranean, by the Marchese di Monterosato.—On the fossils of the crystalline limestone of the Casale and Bellampo Mountains in the province of Palermo, by Prof. G. G. Gemmellaro.

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. xii. fasc. viii.—Mechanical demonstration of the second principle of thermodynamics, by S. Crotte.—On functions whose first derivatives belong to the class zero, by Prof. Ascoli.—Imaginary plane of linear complex and its intersections, by S. Aschieri.

Fasc. ix.—Prophylaxis of the plague, by Dr. Zucchi.—Researches on the electric conductivity of carbon, by Prof. Ferrini.—On the product of the more integrable and finite functions, by Prof. Ascoli.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, June 12.—C. W. Merrifield, F.R.S., president, in the chair.—Mr. R. C. Rowe was proposed for election.—The following communications were made:—Notes on the reduction of a system of forces; and on plane curves, by Mr. J. J. Walker.—Notes on determinants of *n* dimensions, by Mr. Lloyd Tanner.—Curves for the inscription of a regular nonagon and undecagon in a circle, by the Rev. Dr. Freeth.—On Clifford's graphs and on the twenty-one co-ordinates of a conic in space, by Dr. Spottiswoode, P.R.S.—Two geometrical notes, by Prof. H. J. S. Smith, F.R.S.

Chemical Society, June 5.—Mr. Warren De La Rue, president, in the chair.—It was announced that a ballot for the election of Fellows would be held at the next meeting (June 19).—The following papers were read:—A contribution to the theory of fractional distillation, by T. E. Thorpe. The author has observed that of a mixture of equal volumes of carbon tetrachloride, boiling point 76°·6, and of methyl alcohol, boiling-point 65°·2, 46·5 per cent. of the whole distils over at 55°·6–55°·9, 10° lower than the boiling point of its most volatile constituent.—Preliminary note on the action of organo-zinc compounds on quinones, by F. R. Japp. The author has studied the action of zinc ethyl on phenanthrene quinone and obtained a substance crystallising in faintly-yellowish plates having the composition $C_{16}H_{14}O_2C_2H_6O$; he hopes by these reactions to distinguish quinones from double ketones.—Third report to the Chemical Society on researches on some points in chemical dynamics, by Dr. Wright, Messrs. Luff and Rennie. This is a lengthy paper in which the action of carbonic oxide and hydrogen on a uniform weight of copper oxide has been studied at various temperatures; the results are plotted out in numerous curves; in all cases carbonic oxide reduces more quickly or at a lower temperature than hydrogen.—On fractional distillation, by F. D. Brown. The author has studied with great care the distillation of mixtures of benzene and carbon disulphide.—On chlorstannic acid, by J. W. Mallet. A bottle containing a strong solution of stannous chloride after standing for a year deposited a transparent jelly-like substance which proved to be SnO_2HCl. Soda and ammonia salts were obtained.—On indigopurpurin and indirubin, by E. Schunck.

Baeyer and Emmerling obtained a red-colouring matter from isatin, which they named indigopurpurin; this is identical with indirubin obtained by the author from indican. The author considers that the name indigopurpurin should be abolished.

Physical Society, May 24.—Prof. W. G. Adams in the chair.—New Members: Mr. Sedley Taylor, M.A., and Mr. Walter Emmott, A.S.T.E.—Mr. W. J. Wilson exhibited a new harmonograph and figures drawn by it. The figures drawn by prior harmonographs are all more or less imperfect owing to loss of motion in the pendulums actuating the marking pen; and Mr. Wilson therefore designed a new harmonograph which not only gives perfect figures but admits of the phase of either of the two compounded motions being decreased by a known amount. In this instrument toothed wheels take the place of pendulums, the ratio of the teeth giving the ratio of the periods of the motions. By employing the device of an intermediate wheel gearing with two others, and arranging two or more wheels on the intermediate axle, a great variety of phase can be obtained for each motion. An ingenious adjustment by means of a movable nut allows the phase of either or both motions to be altered to a known extent, and thus an endless variety of figures can be obtained. As in other harmonographs a writing-table on which the paper is placed, and an aniline glass pen, are used. Several of the figures done also on glass were thrown on the screen, the stereoscopic effect being very apparent. In reply to a query Mr. Wilson said that he had adapted some of the figures to the stereoscope.—Prof. Hughes explained his new induction balance and showed some of its principal effects. It is well known that on starting an electric current along a wire adjacent to another wire, an induced current is set up in the second wire in an opposite direction to the first or primary current. In the induction balance two primary circuits or coils are taken, with the same current (interrupted by a microphone acted upon by the ticking of a clock) running through both, and between these is placed a secondary circuit or coil in connection with a telephone. The primary coils are so wound as to oppose each other's induction on the intermediate secondary. There is a point, moreover, between these, where these opposed inductive influences exactly neutralise each other. If the secondary coil be placed there, no induced ticking of the clock can be heard; but if the secondary be displaced to one or other side of this point, the ticking can be heard in the telephone increasing in loudness as the secondary approaches one or other of the primaries. If the distance between the primaries be graduated into a scale, this contrivance becomes a sonometer, since it gives an absolute zero of sound, and degrees of loudness. It is well adapted for measuring the hearing power of the ear. By splitting the secondary coil into two parts and placing each close to its proper primary, so that there are four coils in all arranged in two pairs, the extremes in one primary circuit, and the means in one secondary, the two opposing parts of the balance can be separated from each other, so as not to disturb each other's action, and the balance made very sensitive by the closeness of the primaries and secondaries. Prof. Hughes finds that there is a line or zone of maximum induction midway between each primary and its secondary. If a conductor such as a piece of metal be put in this position it has a maximum disturbing effect on the balance, due probably to the electric currents generated in it by the induction. The effect is apparently proportional to the conductivity of the metal. It requires an exactly similar piece of metal put between the other pair of coils to restore the equilibrium of the balance. A difference of alloy, or of weight between two like coins is at once observed from the imperfect restitution of the balance; base coins are thus also at once detected. Again, it is possible for a person to tell what particular coin or coins are in one part of the balance by trial of the same coins in his part. When plates of non-magnetic metals are held vertical in the balance their disturbing effect is *nil*; iron on the other hand gives its maximum effect on this position, because its magnetic effect overbalances its electrical effect. Two pieces of iron may therefore neutralise each other as cores in an induction coil. Steel is easy to balance compared with soft iron. Zinc disturbs most when placed along the sides of each pair of coils; iron when in centre at a certain length of metal laid along the outsides of the coils produces silence. The maximum line of inductive force is midway between the coils, and there is a line of minimum force at half the thickness of each coil. A metal placed at these lines of minimum force has no disturbing effect on the balance. Pressure applied to small shot, or spongy gold, alters the balance. The effects of stress, heat, magnetism, light, &c., on matter could be determined by the balance. Prof. W. G. Adams believed that one result of Prof. Hughes's experiments will be the determination of the way in which the law of electro-dynamic induction depends on density. He also imagined that the metal when in the maximum line between the coils gathered the lines of force to itself, whereas when on the minimum lines it could not thus divert them. Prof. Ayrton cited the early experiment of Faraday with a sheet of copper oscillating to rest between two opposite magnetic poles. The copper took a long time to stop; but a sheet of iron placed between two like poles was soon stopped owing to its becoming imbued with an opposite polarity, and deflecting the lines of force. He also suggested that the divergence of the results for conductivity of metals got by the induction balance from those got by the Wheatstone balance might be due to that electric inertia suspected by Sir William Thomson. Prof. Guthrie thought that the induction balance pointed to the conclusion that the disturbing effect of a conducting mass applied in this way is proportional to the quantity of electricity generated in it under certain conditions of temperature, &c. The determination of the conductivity of liquids would be a useful application of the balance. Mr. Chandler Roberts gave some results which he had obtained from an examination of certain alloys by means of the induction balance. He had been able to detect a difference of one part in 1,000 in the amount of silver in two shillings of equal weight. He also pointed out that Mathiessen divided alloys into three classes: (1) solidified solutions of one metal in another; (2) solidified solutions of one metal in an allotropic modification of another metal; (3) solidified solutions of allotropic modifications of both metals. For the first class the curve of electric conductivity is a straight line, for the second a parabolic curve, for the third a bent line. Mr. Roberts found that the balance gave the characteristic curve for the first class with an alloy of lead and tin, and for the second with an alloy of gold and silver. With a copper tin alloy, which is a good example of the third class, he found the curve given by the balance to be intermediate between Alfred Risch's curve of density and Mathiessen's curve of conductivity, and considers that the balance is influenced by the density as well as the conductivity of the metal interposed. Prof. Hughes said that as the working of metals appeared to affect their conductivity he was inclined to rely more on the conductivity measurements of the balance than on those of the Wheatstone bridge. By the balance plain pieces of metal were taken, whereas by the bridge wires were mostly taken. He would rather not give any theory yet as to the results obtained from the balance.—Dr. Erck then exhibited his novel pump for lifting solutions out of batteries. It consists of a closed vessel, funnel-like, the stem dipping into mercury, a column of which ascends the latter to a certain height. Two tubes emerge from the cover, one dipping into the liquid, the other opening to the air. By altering the pressure inside the vessel the solution rises to the latter, and can escape from it by trickling through the mercury.

Anthropological Institute, June 18.—Mr. Hyde Clarke, vice-president, in the chair.—The following new Member was announced: Mr. William Wavell, late of the Bengal Civil Service.—A paper was read by Miss A. W. Buckland on some Cornish and Irish prehistoric monuments. The authoress compared the sepulchral and the non-sepulchral monuments existing in the two countries, pointing out the differences between them, as indicating, either that they were erected by different tribes, or at various periods, and calling especial attention to the absence in Cornwall of the round towers, so common in Ireland, as well as of oghams, and those peculiar markings found in the Irish chambered tumuli at New Grange, Dowth, &c., as also in similar monuments in the north of Scotland and in Brittany. These markings are believed by Miss Buckland to represent the tribal or tattoo marks of the Picts or a kindred race, being one of many different tribes brought by tradition from the neighbourhood of the Euxine, a tradition apparently confirmed by the decidedly eastern characters of the jewellery found in Ireland, as well as by the megalithic monuments which can almost all be traced to Eastern Europe, and thence through Western Asia to India. Notwithstanding this apparently common origin, Miss Buckland pointed out that they are almost everywhere arranged in groups suggestive of a difference of race in their constructors, and expressed a hope that some day a map of the world would be constructed showing these groupings, which would be a great help to students of ethnology and archæology.—Mr. C. Pfoundes also read a paper entitled "Some Facts about Japan and its People," and exhibited drawings in illustration of the same.

Entomological Society, June 4.—H. W. Bates, F.L.S., F.Z.S., vice-president, in the chair.—The following elections took place:—Mr. J. Walhouse, F.R.A.S., Maida Vale, as an Ordinary Member, Señor Antonio Augusto de Carvatho Monteiro, Lisbon, as a Foreign Member, and Mr. C. H. Goodman, Lesness Heath, as a Subscriber.—Mr. McLachlan called attention to a notice lately published by M. F. A. Forel, concerning certain sculptured markings on cretaceous pebbles from the shores of Lake Leman, in which the author has come to the conclusion that the markings were mainly due to the action of larvæ of trichoptera, which formed galleries on the surface. Mr. McLachlan exhibited plaster casts of two small blocks, one of Jurassic limestone, the other of ordinary white chalk which had been placed in the lake by M. Forel for some months, and which showed markings that apparently confirmed the theory that such were due to the agency of trichopterous larvæ, of which some specimens in alcohol were also exhibited.—Mr. J. S. Baly communicated a paper entitled "An attempt to point out the differential characters of some closely allied species of *Chrysomela*, chiefly those contained in Suffrian's 11th group; also descriptions of some hitherto uncharacterised forms belonging to the same and other genera of the family."—The following papers were communicated by Prof. Westwood:—"A decade of new Cetoniidæ," and "On some unusual monstrous insects."—Mr. W. L. Distant read a paper entitled "Contributions to our knowledge of the hemipterous fauna of Madagascar."—Sir Sydney Saunders communicated some notes received from M. Jules Lichtenstein, describing the metamorphoses of the blister-beetle *Cantharis versicatoria*, which he had recently succeeded in rearing from the egg.—Mr. Meldola communicated a translation of a paper by Dr. Fritz Müller, recently published in *Kosmos*, entitled "Ituna and Thyridia; a Remarkable Case of Mimicry in Butterflies."

Victoria (Philosophical) Institute, June 16.—The president, the Earl of Shaftesbury, in the chair.—Capt. F. Petrie (the Honorary Secretary) read the report. It appeared that the Society had lost twenty by death, and twelve members and eighteen associates by resignation, since the last annual meeting, but that eighty-six new members had joined in that time. The total number of members is now 785. The address was delivered by Dr. Radcliffe, and took the form of an inquiry into the present position of physical science.

EDINBURGH

Royal Society, June 16.—Prof. Maclagan, vice-president, in the chair.—The following communications were read:—Atomicity or valence of elementary atoms: is it constant or variable? by Prof. Crum Brown.—On the action of heat on salts of primethyl-sulphine, part iv., by Prof. Crum Brown and J. Adrian Blaikie, D.Sc.—Comparison of the salts of methyl-diethyl-sulphine, and of ethyl-methyl-ethyl-sulphine, by Prof. Crum Brown and J. Adrian Blaikie, D.Sc.—On the bursting of fire-arms when the muzzle is closed by snow, earth, grass, &c., by Prof. George Forbes.—On some new bases of the leucoline series, part iii., by G. Carr Robinson and W. L. Goodwin.

BOSTON (U.S.A.)

American Academy of Arts and Sciences, May 14.—Hon. Charles Francis Adams in the chair.—Dr. H. P. Bowditch presented a new form of plethysmograph differing from those of Mosso and von Basch in the method adopted for securing a constant level of the fluid in the receptacle connected with the apparatus which contained the body whose changing volume was to be measured. The method consisted in suspending the receptacle (a large sized test tube) to a delicate spiral steel spring of which the length and strength were so adjusted that the weight of the fluid flowing into the test tube caused an elongation of the spring precisely equal to the rise of the fluid in the test tube itself. Thus the absolute level of the fluid in the receptacle remained unaltered, and a constant pressure was maintained upon the surface of the organ to be measured. An index attached to the lower end of the spring recorded upon a revolving cylinder covered with smoked paper the flow of the fluid into and out of the receptacle.—Mr. N. D. C. Hodges gave two new proofs of the dimensions of molecules, one based upon the properties of water and aqueous vapour, the other upon superficial tension and considerations of the depth of the superficial layer of molecules upon sheets of platinum.—Prof. Pickering exhibited a new form of photometer for measuring the light of a nebula or comet, by comparison with a star thrown out of focus. The method employed eliminated the effects of moonlight or twilight. He also proposed to denote the light of these bodies in stellar magnitudes. Thus a portion of a nebula would be of the twelfth magnitude, if of the same brightness as a twelfth-magnitude star spread over a circle one minute in diameter.—Prof. John Trowbridge presented two contributions from the Physical Laboratory of Harvard College, one on the vibration of elliptical plates, and one on a new method of studying wave-motion and vibrations on the surface of mercury. The mercury is covered with a very thin film of lycopodium dust, and is illuminated by the electric spark produced by breaking a circuit on the surface of the mercury.—Prof. C. Loring Jackson and Mr. J. Fleming White announced a new synthesis of anthracene.—Prof. Asa Gray presented the characters of new species of plants from Mexico, collected by Dr. E. Palmer and Dr. C. C. Parry.—Prof. Wolcott Gibbs, a research on complex inorganic acids; and Mr. Sereno Watson, a revision of the North American liliaceæ and descriptions of some new species of other orders.

PARIS

Academy of Sciences, June 9.—M. Daubrée, president.—The following papers were read:—Chronometric observatories for the merchant marine, by M. Faye.—On the spherical regulating spiral of chronometers, by M. Phillips.—On the bases derived from aldehyde-ammonia, by M. Ad. Wurtz.—Determination of the height of the mercury in the barometer under the equator; amplitude of diurnal barometric variations at various stations in the Cordilleras, by M. Boussingault.—Increase of albumenoid matters in the saliva of those having albumenuria, by M. Vulpian.—On the spectrum of nitrate of didymium, by MM. Laurence Smith and Lecoq de Boisbaudran.—On the spectrum of nitrate of erbium, by M. Lecoq de Boisbraudran.—Observations made during the voyage of the frigate *La Magicienne*, by Admiral Serres.—The following papers were among the correspondence:—Observations of Comet II., 1867, made at the Observatory of Florence (Arcetri), by M. Tempel.—Transformation of a pencil of normals, by M. A. Mannheim.—On the use of elliptic functions in the theory of the plane quadrilateral, by M. G. Darboux.—On developments in series whose terms are Laplace's functions Y_n, by M. A. de St. Germain.—On the laws of dispersion, by M. Mouton.—On Stokes's law, by M. S. Lamansky.—On the absorption spectra of alizarin and some colouring-matters derived from it, by M. A. Rosenthal.—On the *verglas* of January 22, by M. de Tastes.—On the dissociation of ammonium sulphide, by MM. R. Engel and Mortessier.—Action of the vapour of water on carbonic oxide in presence of a red hot platinum wire, by M. J. Coquillion. On some derivatives of methyleugenol, by M. Wassermann.—On an isomer of angelic acid, dimethyl-acrylic acid, by M. E. Duvillier.—On the action of phenate of sodium in bacteriemic frogs, by M. Bacchi.—Hematic lesions in chlorosis, the serious anemia named progressive, and the anemia of nephritis, by M. Quinquand.—Researches on the localisation of arsenic in the brain, by MM. O. Caillol de Poncy and Ch. Livon.—Rectification in a communication of March 17 last, by M. Feltz.—Erratic blocks of the Valley of Lys (Haute-Garonne), by M. Gourdon.—Fall of meteorites on May 10, 1879, in Emmet County, Iowa, U.S., by Prof. Hinrichs.

CONTENTS

THURSDAY, JUNE 26, 1879

HISTORICAL SUN-DARKENINGS

NOT a few persons appear to have been much exercised by a prognostication emanating from an American source, whereby the public are forewarned of an approaching period of sun-darkening to extend over several days. History does record instances in which the sun has been abnormally obscured or its light paled to such an extent that stars have come into view in the daytime, and Erman, Humboldt, and other writers have brought these occasions into prominent notice, the former in connection with the presumed passage of dense meteoric streams between the earth and the sun. The earliest mention of such a phenomenon appears to be in the year B.C. 44, about the time of the death of Julius Cæsar, when we read in Plutarch and Dio Cassius that the sun was paler than usual for a whole year, and gave less heat, the air continuing cold and misty. The darkness for two hours on August 22, A.D. 358, appears to have preceded the great earthquake of Nicomedia. Two years later in all the eastern provinces of the Roman Empire we are told there was "caligo a primo auroræ exortu adusque meridiem," and the stars were seen, the further description being rather applicable to a total solar eclipse; but neither the eclipse of March 4, 360, nor that of August 28, would be visible in those parts. Again, when Alaric appeared before Rome, the darkness was such that stars were seen in the daytime (Schnurrer, "Chronik der Seuchen"). Following the *Tablettes Chronologiques* of the Abbé Lenglet Dufresnoy, Alaric invested Rome A.D. 409, and became master of the city on August 24, 410; there was a visible eclipse of the sun on June 18 of the latter year, therefore while the siege was in progress; but on calculating the circumstances under which it would be seen at Rome, introducing the latest lunar elements, it appears that little more than half the sun's disk would be covered at the greatest phase about 2h. 40m. P.M., and no sensible diminution of sun-light would be occasioned by the eclipse. In 536, 567, and 626 we find mention of long periods of diminished sun-light. Schnurrer records that in 733, a year after the Saracens had been driven back beyond the Pyrenees, consequent on their defeat at Tours, "the sun darkened in an alarming manner on August 19; there appeared to be no eclipse by the moon, but rather an interruption from some meteoric substance." There was an eclipse of the sun, annular but nearly total, on the morning of August 14; it is mentioned in the Saxon Chronicle, which tells us "the sun's disk was like a black shield." The near coincidence of dates suggests in this case a connection between the darkness and the eclipse. In 934, according to a Portuguese historian, the sun lost its ordinary light for several months, and this is followed by the doubtful statement that an opening in the sky seemed to take place, with many flashes of lightning, and the full blaze of sunshine was suddenly restored. In 1091, on September 29, not 21, as given in some of the translations of Humboldt's *Cosmos*, Schnurrer relates that there was a darkening of the sun which lasted three hours, and after which it had a peculiar colour which occasioned great alarm. In another place we read: "Fuit eclipsis Solis 11 Kal. Octob. fere tres horas: Sol circa meridiem dire nigrescebat": there was no visible eclipse at this time, and the November eclipse was central only in the southern parts of the earth. A century later, or in June, 1191, according to Schnurrer, the sun was again darkened, with certain attendant effects upon nature: here the cause is easily found; on June 23 there was a total eclipse, in which the moon's shadow traversed the continent of Europe from Holland to the Crimea; the eclipse was total in this country between the coasts of Cumberland and Yorkshire. Erman refers to a sun-darkening on February 12, 1106, which was accompanied by meteors, and we read in the cometographies that on the 4th, or, according to others, on the 5th, of February in this year a star was seen from the third to the ninth hour of the day, which was distant from the sun "only a foot and a half." Matthew Paris and Matthew of Westminster term this star a comet, and we may take it to have been the same which, later in the same month, was observed in China under the sign Pisces, and which at one time was supposed to have been identical with the great comet of 1680; this body, however, would not appear to have been sufficiently near the earth as, even on the assumption of a denser constitution than usual with comets, to account for a diminution of the solar rays, by its intervention. On the last day of February, 1206, according to a Spanish writer, there was complete darkness for six hours. In 1241, "five months after the Mongol battle of Leignitz," the sun was so obscured, and the darkness became so great, that the stars were seen at the ninth hour about Michaelmas. In this case, again, the darkness referred to was undoubtedly due to the total eclipse on October 6, of which Prof. Schiaparelli has collected a full account from the Italian writers. Lastly, in 1547, from April 23-25, Kepler relates on the authority of Gemma, "the sun appeared as though suffused with blood, and many stars were visible at noon-day." Schnurrer thought this phenomenon was what the Germans call an "Hohenrauch," notwithstanding the visibility of stars.

From the above brief summary of what have been considered abnormal sun-darkenings, we see that in several cases the diminution of light has been due to the ordinary effects of a total eclipse, while it is clear that there are no grounds in the historical evidence for any prediction of a period of darkness. The nervous in these matters, and it would really appear that such exist, may take consolation therefrom.

J. R. HIND

SCIENCE AND AGRICULTURE

BRITISH agriculture, in most of its aspects, will come into prominent notice next week. The great show at Kilburn, coming as it does just now at a time of great depression for farming at home, ought to teach us some useful lessons. It should tell us that the days of rule of thumb, the days in which we did as our fathers did are over. New means, new methods, new materials, new economies, new crops, must be associated with wider views of what the world wants and with more precise knowledge of what our little islands can best supply.

If we study soils, manures, crops, live stock, implements, the after-treatment of farm produce, or the instruction of agriculturists and of labourers—in every direction we shall learn how beneficial has been, and may still be,

the influence of the scientific method upon the agricultural art.

Anlaysis of soils has not answered the questions put by its means exactly as we expected. But it has frequently shown us why, through excess or defect of some ingredient, certain lands were barren, and it has taught us how cheaply and thoroughly to remedy their sterility. Excess of decaying organic matter, of soluble salts, or the presence of ferrous salts, or of iron pyrites, these have been recognised amongst the curable ills of our soils. What is known as the *coagulation* of clay is now understood, so that we can often bring it about and thus render heavy lands workable at our will. The relations between the fungi inimical to our cultivated plants and the constituents of our soils being known we can now fight more hopefully against blight and mildew. What kind of exhaustion of soil is to be feared and how it can be remedied is now within our knowledge.

The development of the industry of artificial manures has been a very marked feature of the whole period of forty years during which our great Agricultural Society has been in existence. Farmyard manure has been relegated to its true place—no mean one, but one which has no longer the importance once attached to it. As 100 tons of ordinary dung and litter do not contain more than 1 ton (often less) of real manurial substance—potash, nitrogen, phosphorus pentoxide—one hundredweight of guano may frequently replace with advantage the usual dressing of farmyard manure applied to an acre. But while chemistry has searched out the constituents of manures, and recognised and determined the elements of fertility scattered in minerals and guano and waste products throughout the world, and shown how to bring all plant food into available forms, it has had also to carry on a perpetual warfare with the bands of adulterators, perfecting its methods of detecting the falsification of the materials which it has itself introduced; for manures are difficult to test by mere inspection, often being merely "dirts with a strong smell."

The improvement of existing varieties of plants by artificial selection has been carried to great perfection in many instances—the sugar-beet and wheat being notable examples. The introduction and improvement of new plants, both for cattle food and for the sustenance of man, is a work in which much remains to be done. Especially should attention be directed to those crops upon which lesser, but in many cases more, remunerative industries than mere corn-growing may be founded. Plants yielding products useful in medicine, dyeing, and perfumery, should not be neglected. Some districts on the Continent, such as the neighbourhood of Florence, have been immensely benefited in every way by the introduction of minor crops with their attendant industries; similar successes may be repeated where skill and capital are available, climate and soil being of course taken into account.

Of improvement in the breeds of horses, cattle, sheep, and pigs, nowhere can be found better illustrations than in England: we shall soon see how much our neighbours and friends abroad have gained from our work in this direction. In agricultural machinery and implements the same statement may be made with still greater emphasis: it is indeed curious to note how in every text-book of agriculture, in every farmer's journal, and rural advertisement published in France, Germany, Italy, and in most other countries both of the Old World and the New, the familiar names of Howard, and Fowler, and Cambridge, and Aveling, meet us on plough, and roller, and harrow, and engine. Perhaps in the after-treatment of some kinds of ordinary farm produce, we have been behind our Continental neighbours and American cousins, but we are beginning to appreciate better the aids that science can render to cheese and butter-making, and to the preparation of mill-products from wheat. The critical study of milk and dairy processes is securing the attention of dairy-farmers in England; while such an invention as Wegmann's porcelain cylinder for milling wheat has revolutionised the old grinding process already.

Of progress in the agricultural education either of farmers or farm-labourers, we have little to boast. Our solitary Agricultural College at Cirencester has been ever and anon paralysed by mismanagement; while its charges are too high, owing to the absence of any endowment, for its instruction to be accessible to the sons of ordinary farmers. Agricultural newspapers are neither as cheap nor always as instructive as they should be; the education in our elementary schools has hardly yet acquired that agricultural bias which in rural districts might be so advantageously given to it. Still the Science and Art Department has begun a good work by instituting its examination in the principles of agriculture, although its syllabus presupposes that the examinees will have been been fed on far richer and more varied stores of learning than are yet at their disposal.

This Kilburn Show will then direct our attention to a multiform subject of the greatest national importance at the present crisis. We shall hope to learn much from the exhibits in the eight miles of shedding arranged in due order over more than 100 acres of ground, and to be rewarded with over 13,000*l.* in prizes.

THE ELECTRIC LIGHT

THE Committee of the House of Commons appointed to inquire into the value of the electric light has completed its labours and has issued its report. There is no doubt that the evidence given before it, when published, will be very useful, and that the report itself is a careful digest of the facts elicited, but it is questionable whether the results of the inquiry, or the conclusions of the Committee, will satisfy any one. Our readers will find in it nothing new. Gas engineers will find in it their extermination calmly contemplated. The gas manufacturer is told that he has nothing whatever to do with electricity. Gas, and nothing but gas, is his ware. Though he was incorporated to illuminate a city with the then best known illuminant, he is not to touch a newer illuminant because he will check the development of the fresh source of light, and his present mode of production is quite different to that required for the new commodity. It is as though a wine merchant who had a large sale of sherry were not allowed to sell beer, or a dairyman were not allowed to sell asses' milk because he only kept cows. The enunciation of such a proposition in a Parliamentary Report is sad. Worse than all, municipal

authorities are advised that they can ruin all the gas interests without the distribution of any compensation whatever. Surely the enormous capital sunk by the public in gas enterprise deserves some consideration from its representatives in Parliament assembled. Are our vestries and corporations so immaculate that they are to have entire control of our supplies of water and of light? Why not give them the supply of food and of heat? The line must be drawn somewhere, and it is well that Parliament should hesitate in the complacency with which it now thrusts on irresponsible communities the distribution of vital necessaries.

The only sphere in which electricity has made itself useful and practical as an illuminant is in our lighthouses, and though it is eminently adapted for nautical purposes, as ordinary ships' lights, or to illuminate the sails of a ship, the Report is silent on the point and on the absurd restrictions which have been placed by the Board of Trade on its use at sea.

The statement that the energy of one-horse power when converted into gas-light only gives 12-candle power, and into electric light 1,600 candle power is startling if true. Without the evidence before us on which this statement is made we cannot well contravene it, but it seems based on some fallacy. We remember seeing somewhere, but cannot recall where, a somewhat similar estimate, but it was based on the assumption that the whole of the coal was consumed in producing gas, and no allowance whatever was made for the coke, tar, and other products of distillation. Is it so in this instance? Though 3 lbs. of coal consumed in one way may give one horse-power, and in another way 12-candle light, it by no means follows that one-horse power is equivalent to 12-candle gas-light—for in the case of gas we do not know the remanent energy.

The report fully confirms the opinion we have frequently expressed that the electric light sensation was due to a scare and not to any real progress or new discovery made. The transmission of power for mechanical purposes is foreign to the inquiry, and the suggestion that currents used by day for mechanical purposes can be used at night for illuminating purposes assumes what we only wish were true, that there is no mechanical work done in England in hours of darkness.

The general conclusion arrived at is that we can do no more with the electric light at present, but that we must do nothing to restrict its development. We did not require a Parliamentary Committee to tell us that.

INDIAN GEOLOGY

A Manual of the Geology of India. By H. B. Medlicott, M.A., and W. T. Blanford, F.R.S. Published by Order of the Government of India. (Calcutta, 1879.)

THE appearance of this long-promised work marks an epoch in the history of Indian science. In two moderate octavo volumes (paged as one) and the map which accompanies them, we have placed before us, in an attractive and convenient form, the matured conclusions of upwards of thirty years' systematic survey of the geology of our Indian possessions; and now, for the first time, the geological structure of India, or, at least, its leading facts, may be mastered by the student at no greater cost of labour than is involved in a few days' study of a well-arranged and thoroughly trustworthy manual.

We are reminded almost in the opening words of the preface, how many of those who have contributed to the researches on which this work is based, have now passed from among us. Stoliczka, J. G. Medlicott, the two Oldhams, Williams, and Loftus are only a few of the better known names among the many that for a longer or shorter time have been borne on the rolls of the Indian "Geological Survey," whose bearers lie in Indian graveyards, or beneath some modest tomb on the out-skirts of an Indian village, or who finally have returned with shattered health to the land of their birth, only to bring to a close among their friends the last few enfeebled months of their career. Of the earlier labourers in the field, of those who witnessed the birth of the "Geological Survey of India," and who three-and-twenty years ago wielded their hammers in breaking open the secrets of Indian rocks, but three still remain members of the Survey Staff, and to two of these surviving members whose names stand at the head of our article, we are indebted for the present masterly summary of the common labours of all.

The contributions of the two authors to the joint work are distinct, and in point of magnitude unequal. To Mr. W. T. Blanford has fallen the lion's share of the labour. Of the thirty chapters which (including the introduction) make up the work, Mr. Medlicott contributes ten, viz., those on the metamorphic and azoic rocks of the peninsula, and those on the geology of the Himálaya east of the Jhelum, and on Assam. The remaining twenty chapters, including the introduction, which deal with all the fossiliferous and neozoic rocks of the peninsula, the geology of Sind, the Punjab and Burma, and the Sivalik fauna generally, are the work of Mr. W. T. Blanford. The map,[1] which is printed in colours and is on the scale of sixty-four miles to the inch, has been compiled in the office of the Geological Survey, from materials in part unpublished. It professes to be only a preliminary sketch map, and three small tracts in the peninsula, the greater part of the Bikanir Desert and Guzerat, the Nepalese Himálaya, and Arakan and the adjoining hill tracts are left uncoloured. But with these exceptions it exhibits in as detailed a form as the scale admits of, and with unquestionable accuracy, the extent and boundaries of the several formations, classed as Alluvium, Upper and Lower Tertiary, Cretaceous, Jurassic, Triassic, Carboniferous, Silurian, Submetamorphic, Metamorphic, Granitic, Volcanic; and in the peninsular area, Upper and Lower Gondwána, and Vindhyan, the meaning of which unfamiliar and special classification we shall presently have occasion to notice.

The subdivision of the whole region into a peninsular and an extra-peninsular area is one of fundamental importance, and, as such, is treated in the arrangement of the manual. Geographically, the two areas are separated by the broad unbroken alluvial plain which stretches along the foot of the mountain zone from the mouths of the Indus to those of the Ganges; and geologically both in

[1] A copy of this map was sent for exhibition to the Great Paris Exhibition last year, but was probably seen by few. In fact, it was suspended in the office room of the Indian department, avowedly for want of room. Meanwhile a conspicuous case in the centre of the transept was devoted to the exhibition of Indian pickles.

history and structure, they present many strongly-contrasted features. In the words of one of the writers, "This [the extra-peninsular area] is geologically an intrinsic portion of the Asiatic continent, whilst peninsular India is not." For many years, indeed, it seemed that there was scarcely any stratigraphical link between the richly fossiliferous formations of Sind, the Salt Range, and the Kumaon Himálaya on the one hand, and on the other, the plant-bearing or azoic shales, and thick-bedded sandstones, described by Newbold, Williams, Voysey, Hislop, and others, which, with volcanic and metamorphic rocks, make up the greater part of the peninsula. While, with the exception of the later Himalayan and Sind tertiaries, the former are in the main of marine origin, a large portion of the latter are the characteristic deposits of fresh water; and, as regards the less ancient and fossiliferous formations, the apparently conflicting indications of age afforded by their fossil remains left it long impossible not merely to correlate them with any recognised members of the extra-peninsular formations, but even to assign to them with any confidence an approximate place in the general scale of geological sequence. Nor can this problem even now be considered as fully solved. But the scraps of evidence which, one by one, have been brought to light in the continued progress of the Survey have greatly simplified it, and this evidence is ably analysed and summed up in the first volume of the manual. The plant-bearing formations of the Peninsula are now regarded as one great system, to which the name Gondwána has been given, subdivided into an upper and lower series, and it represents the deposits of an ancient system of river valleys, dating from Permian and lasting to Tithonian times. The lesson in geological reasoning, inculcated by the geology of these rocks, is one that deserves to be carefully pondered, and in illustration of the difficulties which it presents, we will quote one or two passages from the fifth chapter of the Manual. To render the description more clear to the general reader we preface them with an excerpt from the tabular synopsis of the Gondwána formations at p. 108, exhibiting the accepted stratigraphical relations of the different groups referred to. It includes four only of the eight regions summarised in the original table.

	General Sequence.	Satpúra Region.	Godaveri Valley.	East Coast Region.	Cutch.
Upper Gondwána.	Cutch and Jabalpur	—	Chikiála	Tripelty	Umia
		Jabalpur		Sattavedu (?) ...	Katrol
	Rajmahal and Mahadeva	Bagra ...	Kota-Maléri ...	Ragavapuram and Sripermatur	—
		Denwa..		Golapilli	—
		Pachmari	—	—	—
Lower Gondwána.	Panchet ...	Almod(?)	Kámthi (including Mangli)	—	—
	Damúda ...	Bijori ...		—	—
		Motur ...		—	—
		Barákar.	Barákar	—	—
	Talchir ...	—	—	—	—
		Talchir..	Talchir	—	—

"[Dr. Feistmantel] ascribes to the whole series an age ranging from Lower Trias or Bunter (Talchír and Damúda) to Middle Jurassic or Bathonian (Jabalpúr and Umia). His determinations, however, being founded exclusively on a comparison of the Gondwána fossil plants with those of European formations, are very frequently opposed by other fossil evidence. The Umia beds of Cutch, for instance, the flora of which is considered by Dr. Feistmantel of the same age as that of the Jabalpúr group, which is the highest Gondwána subdivision, contains several plants found also in the Lower Oolites of Yorkshire, but the Cephalopoda of the marine beds, which immediately underlie the Umia plant beds, and are, to some extent, interstratified, have been shown by Dr. Waagen to be uppermost Oolitic (Portland and Tithonian) forms; and to be separated by two distinct groups of beds, each with a well-marked fauna, from the underlying strata, in which lower Oolitic Cephalopoda occur. In the Damúdas and their representatives, on the other hand, although a few fossil plants are allied to Triassic species, several of the most abundant and characteristic forms are unknown in the Trias of Europe, but are represented by the same or nearly allied plants in the coal measures of Australia, the lower portion of which is certainly of Carboniferous age." Again, "As an example of the difficulties presented in the present state of our knowledge by the contradictory evidence afforded by the fossils of one group, the case of the Kota-Maléri beds may be cited. The Kota beds consist of limestone, and contain remains of fish which have a liassic facies. The Maléri (or Malédi) beds have yielded two reptiles, *Hyperodapedon* and *Parasuchus*, and a fish, *Ceratodus*, all of which are closely allied to European triassic forms. In these Maléri beds some plants have been obtained common to the Jabalpúr and Sripermatur groups, the flora of the former of which has been shown to be in part identical with that of the Umia group of Cutch. The singularly contradictory evidence of age afforded by this Umia flora has already been mentioned. The Kota beds with their liassic fish have now been shown to be so closely connected with the Maléri clays and sandstones, containing triassic reptiles and fish and jurassic plants, that both are classed in the same group."

The conclusion which Mr. Blanford draws from this apparently conflicting evidence is the following:—

"Assuming that the association of similar marine forms in the rocks of distant countries—for instance in the Carboniferous limestone of Europe, the Punjab in India, and Australia,—implies that the rocks are of contemporaneous or nearly contemporaneous origin, the remarkable combination of fossils in the Kota-Maléri beds seems to show that, in mesozoic times, there was a wider diversity in the forms of terrestial life inhabiting distant regions at any given period than there was in the faunas of the surrounding seas. This view is in accordance with the very similar conditions now found prevailing upon the earth's surface, there being a much greater difference between the terrestrial faunas and floras of Africa, Australia, and America, for instance, than there is between the animals inhabiting the Atlantic, Indian, and Pacific Oceans. . . . . There appear, in short, good reasons for believing that the terrestrial area of the world was divided into zoological and botanical regions in past times as it is at present, and the fauna and flora of India may have differed at times, more from those then existing in distant countries, than from the animals or plants which prevailed in the same distant regions at a different geological epoch."

At the very base of the Gondwána system occurs that remarkable bed of silt containing transported boulders which is held by the authors, and we believe we may now say by all members of the Geological Survey of India, to afford evidence of the action of ice, probably ground ice; and it is not a little striking that the most conclusive evidence of this agency, viz., polished and grooved boulders resting on a surface of limestone equally polished and scored, was met with in latitude 20°, at an elevation of about 700 feet above the sea. The resemblance of this bed to that at the base of the Karoo formation of South

Africa, and indeed the palæontological and physical parallelism of the Karoo and Gondwána formations generally is now well known.

The peninsular area affords no instance of any fossiliferous rock of older date than the Gondwána system. But a large area to the north of Madras, another in Chhatisgarh, east of Nagpur, a third very extensive tract in Bundelkhand and Malwa, partly covered by trap, but still exposed over a surface of 40,000 square miles, and some smaller tracts in the valleys of the Kishna and Bhima rivers are occupied by a massive and quite unaltered series of sandstones, limestones, and shales of great thickness which have received the name of the Vindhyan System. From the fact that both in Bundelkhand and Hyderabad diamonds are found imbedded in these rocks, the name "diamond sandstone" was given by Capt. Newbold to a portion of these rocks, but the name was erroneously extended to the much later sandstones of the Gondwána formation, an error only cleared up by the labours of the Geological Survey. Beyond the fact that the Vindhyan system cannot be newer than Lower Palæozoic, nothing whatever is known of its age. Repeated search in the limestones and shales, however promising in appearance, has revealed no trace of any fossil organism, and it is impossible to correlate them with any group of rocks in the extra-Peninsular area, or, indeed, elsewhere. Below and older than these again, are two, or perhaps more, series of submetamorphic rocks, which, under various local names, have been mapped and described in many parts of the Peninsula, and all rest on the fundamental gneiss, which, whether of one or many ages, is everywhere the oldest rock, and is still exposed over nearly half the area.

The only remaining extensive formation of the Peninsula is the great Deccan trap-flow, the most extensive volcanic formation in the world. The age of this formation is now definitely fixed as Upper Cretaceous. Except in the neighbourhood of Bombay, where it dips with a gentle inclination beneath the sea, the successive flows are perfectly horizontal, occasionally interbedded with thin deposits of freshwater origin, and at one place, near Rajahmahendri, with an estuarine deposit. The area still covered by this formation is estimated at little less than 200,000 miles, and there are proofs of its former existence throughout nearly ten degrees of latitude and sixteen of longitude. For the discussion of the many interesting problems presented by this great manifestation of volcanic energy, we must refer the reader to the original work.

In passing from peninsular India to the encircling mountains we pass from an old continent to a new one, from a relic of a mesozoic land area, to the Asia of tertiary and post-tertiary times, and from a region where prolonged denudation has long since obliterated all but the merest traces of original mountain structure, leaving water-worn bosses of hard crystalline rock-cores or scarped slopes and sculptured platforms of horizontal trap or sandstone, to one where the latest deposits of tertiary times are so contorted and faulted as to render the task of disentangling the geological relations of the formations sometimes one of extreme difficulty.

The history of the Himálayan system, which, in addition to the Himálaya proper, includes the Indus ranges and those of the Burmese peninsula, begins in eocene times. It is considered by Mr. Medlicott that the very ancient slaty rocks which now form the greater part of the mountain mass south of the snowy range, and which he designates as the "Lower Himálaya," had undergone no contortion prior to the nummulitic period; and that immediately before its partial depression beneath the nummulitic sea, this area had been long exposed to denudation as "part of a land of doubtful configuration." It is still somewhat doubtful to what age are to be assigned the slaty formations here spoken of. As yet they have yielded no recognisable fossil remains, and they present no such similarity of character to the formations north of the main axis in Zanskar and Hundes, where rocks rich in fossil organisms have been described by Gérard, Strachey, Stoliczka, and others, as to allow of more than a speculative correlation. A recent observation of Mr. Lydekker's in the Pir Panjál range of Kashmir, throws however some little light on the question. The rocks of the slaty series extend in a north-west direction to the Pir Panjál range, and a limestone which there occurs at the top of the series, and appears to be identical with the Krol limestone (also the highest member) of the series near Simla, has been identified by Mr. Lydekker as Carboniferous. From this it would appear that rocks of mesozoic age are completely absent from the Lower Himálaya, and are restricted to certain areas north of the snowy range, and in the extreme north-west to certain parts of Kashmir, and we may add, the western extremity of the Salt Range.

Only in the Eastern Himálaya, viz., at the base of the Sikkim hills, have we any *indubitable* representative of the characteristic fresh water formations of the peninsula. In 1849, Dr. (now Sir Joseph) Hooker, detected some of the well-known fossil plants of the Bengal coal-bearing (Dámúda) formation in certain shaley beds exposed at the foot of the hills near Pankabári, on the road to Darjiling, and this observation, subsequently followed up by Mr. W. T. Blanford, and more recently by Mr. Mallet, has led to the recognition of a band of Lower Gondwána rocks, occupying a narrow zone between the tertiary sandstones of the Terai and the talcose slates of the outer hills. The connection between the Eastern and Western Himálaya remains, however, to be traced out, the intervening kingdom of Nipál being unfortunately closed by the suspicious jealousy of its Hindu rulers, equally to the general traveller, the trader, and the man of science. It is however pointed out by the authors of the Manual, that the probably palæozoic slates, sandstones, and limestones of the Lower Himálaya were originally deposited on a highly eroded surface of ancient gneiss, and probably in hollows, and it is suggested by Mr. Blanford, that like the ancient unfossiliferous formations of the peninsula, they may be of freshwater origin, and that the Lower Himálaya may, after all, have formed a portion of the same palæozoic and mesozoic continent, around the shores of which were deposited the fossiliferous shales and limestones of Zanskár, Hundes, and the Western Salt Range, in which case the chain of the Himálayas must have originated along a portion of the ancient coast-line. And we may observe that the junction of the north and south ranges of the lower Indus valley with the north-west and south-east ridges of the Himálaya coincides in a general way with

the region where the palæozoic and mesozoic marine formations appear to the south of the Himálayan axis, the former in the Punjab and Afghanistan, the latter both there and further south, in Cutch, Sind, and Bálúchistán.

The geography of India in the early eocene period may be represented as something like the following:—The whole of the peninsular area was then, as it now is, land, with the exception of some portions of the present coast tract north of Bombay. In like manner the coast of Kaliwár and the greater part of Cutch were submerged, and a deep sea extended up the present Indus valley, and over Bálúchistán, also over the Punjab and parts of Káshmir, sending an arm up the present Ganges valley, which was in part estuarine, and bounded on the north by a tract of land composed of the then uncontorted rocks of the lower Himálaya. To the east of Bengal the present plain of Silhet and a part of the Khasi Hills were probably covered by a shallow sea, and this extended to the southward over Arakan and at least a large portion of Burmah.

It was in this state of things that the first great disturbance took place, which, repeated again and again during middle and later tertiary times, resulted in the present chain of the Himálaya. The river valleys which, after the first great upheaval, were carved out in the then youthful chain, discharged their stream-borne *débris* as now on the Gangetic plain; and the accumulated conglomerates, sands and clays, which formed around the mouths of the valleys, again and again suffered crushing and upheaval during the subsequent compression of the mountain mass, were added to the hills, and in their turn underwent erosion. But the valleys originally marked out have preserved their general course and function; and the Sutlej, the Bias, the Tous, the Jumna, and the Ganges, still flow out from the mountains along essentially the same lines of drainage which their then nameless representatives followed in miocene times. Such, at least, briefly stated, is the history which Mr. Medlicott and his colleagues have evolved during many years' study of these interesting rocks, first made famous through the classic labours of Cantley and Falconer, and by them named "Siwalik."

Not the least interesting chapter of the Manual before us is that in which Mr. Blanford deals with the rich and varied vertebrate fauna of these tertiary rocks. The original collections of Cantley and Falconer have been largely added to in later years by various members of the Survey; and a comparison of the forms obtained from different horizons in the Sub-Himálaya, the Punjab, Sind, Perim Island, and certain river valleys in the Indian peninsula and Burmah, has led to some modification of the opinions originally held of the geological age of the Siwalik rocks and their contained fauna.

As Mr. Medlicott has shown, the Siwalik rocks are an ancient alluvial formation, like the river fans described by Mr. Drew in Kashmir, and like the *Bhábar* deposits still forming along the foot of the Himálaya at the present day. In what may be termed the typical area, between the Sutlej and the Ganges, disturbances of some magnitude which took place after a portion of these deposits had been laid down, necessitate a subdivision of the series into three groups, upper, middle, and lower, the last of which is termed the Náhun group. It is from the two upper groups that (with perhaps some doubtful exceptions) all the fossils of this special region have been obtained, the Náhun group having remained unproductive to repeated search. An elaborate analysis of the homotaxis of the 45 mammalian genera (consisting of 84 species) which compose this fauna shows that the proportion of living to extinct genera is greater than in most miocene deposits. The presence of four extinct genera not known to range above the miocene period is contrasted with the occurrence of sixteen genera, not found elsewhere at a lower horizon than pliocene or post-tertiary; and there is a close approximation between some of the mammals and the living species of the same genera, the most remarkable of all being the connection of the fossil buffalo, *Bos palæindicus*, of the uppermost Siwalik strata, that of the post-pliocene Jumna and Nerbudda beds, and the Common Indian arnee still existing. Of six species of reptiles sufficiently well known to be comparable, three are common forms now inhabiting the same area, and the fresh-water mollusca also all apparently belong to common existing species. Putting the whole palæontological evidence together Mr. Blanford concludes that a balance is in favour of a pliocene age. This conclusion is strengthened by stratigraphical evidence. At the top of the enormous succession of tertiary deposits of Sind, which have a total maximum thickness of some 30,000 feet, occurs a group termed the Manchar group, about 10,000 feet thick, which is of fresh-water origin and represents the Siwaliks of Northern India. The lower beds of this group pass downwards into the Gaj group (1,000 to 1,500 feet thick), which is of marine origin, and contains a characteristic miocene fauna, "more probably upper than lower miocene." The Lower Manchar beds have yielded a considerable number of mammals, and this fauna, although containing several species in common with the Siwaliks, is altogether older in aspect; the majority of the forms hitherto recognised, belonging to the peculiar types of even-toed ungulates allied to *Nierycopotamus* and *Anthracotherium* intermediate in character between pigs and ruminants, and peculiarly characteristic of the miocene epoch. In these lower Manchar beds is also found a form of *Dinotherium*, a type unknown in the Siwaliks. Remarking that "there can be no reasonable doubt that the Manchar beds of Sind, as a whole, correspond with the Siwalik formation of Northern India, the two being portions of a continuous band of tertiary rocks," it is concluded that the fossiliferous lower beds of the Manchar group correspond to the unfossiliferous Náhuns, and the almost unfossiliferous Upper Manchar beds to the ossiferous strata of the Siwaliks. Mr. Blanford then remarks on the probable climatic causes which have preserved in the Indian pliocene an unusually large number of forms elsewhere characteristically miocene; and compares the case with that of the Pikermi beds in Attica, which are of unquestionable pliocene age. He considers that the general cooling of the north temperate zone at the end of the miocene period caused a migration of many of the characteristic mammals into Southern Asia, the Himálayan chain at that epoch not presenting so impassable a barrier as at the present day, and that such was the case seems to be confirmed by the occurrence of rhinoceros and elephant remains in the tertiary deposits of Hundes

at elevations now occupied only by the yak and similar mountain forms.

In reference to the greater richness of the Siwalik fauna, as contrasted with the Indian fauna of the present day, he quotes with approval the suggestion of Mr. Wallace, that a sweeping reduction was brought about by the cold of the glacial period. Of the influence of this cold in India, there are abundant proofs in the great extension of the Himálayan glaciers, for instance, in Sikkim and Kashmir, down to 6,000 feet and 8,000 feet above sea-level; and in the Naya hills of Assam, whose greatest elevation does not exceed 10,000 feet, in the large moraines at 4,500 feet, described by Col. Godwin Austen.

The oldest proofs of man's occupation hitherto met with in India, are a chipped axe or scraper, in the alluvial (post-pliocene) deposits of the Narbada, associated with remains of *Ursus*, *Elephas*, *Rhinoceros*, *Hippopotamus*, *Tetraprotodon*, and *Bos*, all of extinct species; and a flake, apparently of human manufacture, in the Godavari gravels of similar age. Quartzite implements of the palæolithic type are abundant in the laterite gravels of Madras, but these are probably of later date. Axes of neolithic type have as yet been met with only on the surface, most abundantly in the Banda district of the North-West Provinces.

The Manual is illustrated by twenty-one admirably executed lithographed plates of characteristic fossil forms, and a few woodcuts of sketches and sections. Its utility for purposes of reference is rendered all that can be desired by a copious and well-arranged index. We confidently hope that the publication of the work will give an impulse to the advancement of Indian geology by adding largely to the number of non-professional workers, a class which has hitherto been singularly wanting in India, despite the examples of such men as Carter, Forbes, Newbold, Strachey, and Hislop. H. F. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Prof. Clifford's Mathematical Papers

Having, at the request of Mrs. Clifford and Dr. Spottiswoode, undertaken the editing of the late Prof. Clifford's mathematical papers, I am anxious to secure the co-operation of all mathematicians who are interested in the matter. Prof. Clifford does not appear to have been in the habit of widely distributing copies of his writings, so I have found of many of them a great number of copies, whilst of others I have not come across a single one. I will first state what I have:—

All papers in the *Phil Trans.*, in the *Proceedings of the London Mathematical Society*, in the *Messenger of Mathematics*, in the *Manchester Transactions*, in the *Cambridge Philosophical Society's Journals*, in the South Kensington Handbook, in the *Mathematical Reprint* from the *Educational Times*.

Of the papers in the *Quarterly Journal of Mathematics* I have only §§ 1–11, 17–23, of the *Analytical Metrics*. I should be glad also to have a copy of the *Academy* for August 15, 1873, and information about "Lecture Notes" on Geometry. These last are lithographed and are comprised in twenty-six articles (? all), of which I lack one page, containing § 19–21. I need hardly add I shall be glad to receive any other papers (mathematical) which are not contained in the above-named journals. The Nature article (translation of Riemann) I have. I have Mrs. Clifford's permission to distribute the author's copies of her late husband's papers to mathematicians who may wish to have them. R. Tucker

27, Cantlowes Road, Camden Square, N.W.

Pine-Pollen mistaken for Flowers of Sulphur

The following paragraph appeared in the *Times* of June 16:—

"During the past week, after heavy rain, a thin film of sulphur has been observed at Windsor, Slough, and in the neighbourhood generally, to settle upon the surface of rain-water caught in butts and cisterns. The phenomenon at first did not attract much attention, but being observed on different occasions it has given rise to much speculation as to the cause of it, there being no manufactures in the neighbourhood at all likely to have produced it. It has been suggested that a sulphureous vapour may have been wafted to this country by the recent south-east winds, and arrested and deposited in the rain."

The supposed "sulphur rain," a fine yellow dust, was the cause of great excitement among the country people in this neighbourhood. It was first observed on the afternoon of Sunday, June 8, after a remarkably heavy shower, and much disturbed the inhabitants of some of the villages round Eton, who fancied that it smelt "awful like brimstone," of which its yellow colour was somewhat suggestive. In some places it gave rise to such a feeling of fright that the people were afraid to go to bed, thinking that the judgment day was at hand! Two or three days afterwards there was another "sulphur" shower, and I collected a quantity of the dust with my pupils, who were at work with me in my laboratory at the time. One of them, H. Bury, immediately recognised its resemblance to the pollen of *Pinus pinaster*, with which he is familiar from its abundance in the neighbourhood of his home at Bournemouth; and we have none of us any doubt but that this so-called sulphur is the pollen of this tree or of the Scotch fir, *Pinus sylvestris*, both of which are common in Windsor Forest. Two of the Windsor doctors, both practised microscopists, at once came to the same conclusion; but a local chemist and druggist is said (on good authority) to have supported the sulphur theory. This, perhaps, accounts for the rather positive statement by the Windsor correspondent of the *Times* as to the nature of the deposit, and also for the suggestion he refers to respecting its origin, which explains the phenomenon in a manner that is certainly more curious than probable, from a chemical point of view. I hear that the "sulphureous vapour" is supposed to have been "wafted to this country," after escaping from Etna during the recent eruptions, which fortunately occurred at just the right time to give apparent probability to the sulphur theory.

Thinking that such a remarkable phenomenon should not be allowed to pass unnoticed, I sent a short note to the *Times* of the 17th inst., stating the real (pollen) nature of the yellow dust, hoping that this would set the matter at rest and dispel the superstitious fears of the rustics. I was therefore greatly surprised, a few days afterwards, at receiving a letter from an F.R.G.S. residing near Carlow, in Ireland, who had seen my note in the *Times*, but nevertheless spoke of an "extensive fall of sulphur" in his neighbourhood. He was good enough to inclose me a "specimen of its incrustations" on a dead leaf, and said that "till yesterday's heavy rains any quantity of leaves like that I send you might have been gathered, and the edges of the pools of water were heavily incrusted with pure sulphur." He added that he thought I should not find the deposit to be "the produce of *Pinus pinaster*." This, of course, was rather startling, for I naturally supposed that no one would write so confidently who had not satisfied himself by chemical tests and by microscopical examination as to the truth of his statements, especially after hearing of the mistake which had been made in England. A glance at the deposit under the microscope, however, revealed its true nature—pine-pollen again!

I wrote accordingly to my informant, telling him this and sending him some pollen taken directly from the tree, so that he might recognise its similarity to the "pure sulphur" he so kindly sent me. I hope that by this time he has done so.

The above facts are of interest, partly as affording an excellent illustration of the transportation of pollen by the wind, and partly because they show how ready some people are to attribute an almost miraculous origin to anything a trifle out of the com-

mon, which could be readily explained by any one possessing a little elementary knowledge of science.

P. HERBERT CARPENTER

The Museum, Eton College, June 21

Intellect in Brutes

IN NATURE, vol. xx. p. 147, Mr. H. D. Barclay writes:—"The fact that a cat or a dog subject their food to examination before eating it, does not, most assuredly, prove the possession of abstract powers of thought in the animal. Mr. Romanes here says:—'The motive of the examination being to ascertain which general idea of quality is appropriate to the particular object examined.'

"Here he attributes to an animal whose nature he does not fully understand, his own process of thought, and this appears to me to be a constant source of error in the investigation of animal psychology. That brutes possess self-consciousness, introspection, imagination, abstract thought, cannot, I think, be proved. The fact that animals possess faculties differing from those of man is an insuperable obstacle to a perfect analysis of their intelligences.

"Name these faculties as you please, call them 'inherited habit,' 'inherited memory,' it is perfectly certain that man does not possess them."

Now, far from it being "perfectly certain" that animals possess mental faculties differing in kind from our own, it seems to me that, if we except the so-called "homing instinct" as a faculty about which as yet we know very little, it is "perfectly certain" that there is no other faculty presented by brutes which is not also presented by man. It is the converse proposition that is more difficult to combat—viz., that man possesses faculties of mind which appear at first sight to differ in kind from anything that is presented by animals. Therefore, while I should deem it almost superfluous to "prove" that man possesses "instincts" or "inherited habits" in common with animals, I have never attempted to "prove" that animals possess "self-consciousness" or "introspection" in common with man. Indeed, if Mr. Barclay will again read my article in NATURE, he will see that I expressly state my belief that these, the highest faculties of mind, may be, as the theory of evolution would lead us to expect they ought to be, confined to the highest product of psychological development.

As regards the illustration to which Mr. Barclay objects, I may observe that I selected it for the express purpose of disarming the criticism which he advances. Had I chosen for an illustration some "general idea of quality" more abstract than that of "good for eating or bad for eating," I could better have understood a critic accusing me of attributing to animals my "own process of thought" in the regions of self-conscious introspection. But seeing that I do not myself require or perform any process of introspective thought in order to reject a rotten egg or to regale myself on good roast beef, I cannot understand why I should not attribute to an animal precisely the same general ideas of "good for eating and bad for eating" that in my own case I know to be the causes of my acting precisely as I see animals act. The truth is that in speaking of general or abstract ideas we are not careful enough to discriminate between those simple ideas of quality which spring from mere sensuous associations, and those more elaborated ideas which spring from the more complex associations that are supplied by "mental reflection." But although it is of importance to remember that there is thus a great distinction between these two orders of abstract ideas, it is of no less importance to remember that both orders belong to the same class—all such ideas having reference to quality as abstracted from particular objects of perception, and the only difference between those of the one order and those of the other consisting in the higher degree of elaboration which is supplied to our abstractions by the power of thinking about our thoughts. On the whole, therefore, I maintain that it *can* be "proved" that animals "possess abstract thought" of the inferior order which I have explained, and the phenomena of dreaming which is presented by several animals would seem sufficient proof that some animals, at least, possess a tolerably well-developed "imagination."

GEORGE J. ROMANES

I HAVE been reading with great interest the letters and discussions lately published in NATURE, on intellect in brutes. However, in none of them have I found any notice of a dog recognising a painted likeness of his master or any member of the family. I have seen, in other publications on this subject, that "this is one of the things a dog has never been known to do." During my residence in Cornwall I had a most intelligent and faithful dog for fifteen years. I had him when a month old. His mother was a beautiful liver-coloured spaniel, rather large; his father a black Newfoundland; my dog took after him in colour and shape.

In 1843 a young and self-taught artist asked me to allow him to paint my likeness in oil colours, and I consented. His studio was in the next town, three miles distant, and as often as required I went over; I, however, did not take my dog with me. It was done in Kit-cat size; and he succeeded so well in the likeness and artistic work, that when exhibited at the annual meeting of the Polytechnic Society at Falmouth, a medal was awarded to it, and, as well, it was "highly commended." Not only this, it brought him into notice and gained him lots of employment. The artist was so grateful for my attention that he presented me with the painting, and I still have it. When it was brought to my house, my old dog was present with the family at the "unveiling;" nothing was said to him nor invitation given him to notice it. We saw that his gaze was steadily fixed on it, and he soon became excited, and whined, and tried to lick and scratch it, and was so much taken up with it that we—although so well knowing his intelligence—were all quite surprised; in fact, could scarcely believe that he should know it was my likeness. We, however, had sufficient proof after it was hung up in our parlour; the room was rather low, and under the picture stood a chair; the door was left open without any thought about the dog; he, however, soon found it out, when a low whining and scratching was heard by the family, and on search being made, he was in the chair trying to get at the picture. After this I put it up higher, so as to prevent it being injured by him. This did not prevent him from paying attention to it, for whenever I was away from home, whether for a short or long time—sometimes for several days—he spent most of his time gazing on it, and as it appeared to give him comfort the door was always left open for him. When I was long away he made a low whining, as if to draw attention to it. This lasted for years, in fact as long as he lived, and was able to see it. I have never kept a dog since he died, I dare not—his loss so much affected me. I might tell of many of his wonderful actions; he could do most of such things as are related of other dogs. I am now only anxious to notice this recognition of my likeness, from never having heard of another such fact being recorded of any other dog.

Edinburgh CHAS W. PEACH

A CASE somewhat similar to that mentioned by Dr. Frost, of a cat scattering crumbs, occurred here within my own knowledge.

During the recent severe winter a friend was in the habit of throwing crumbs for birds outside his bedroom window. The family have a fine black cat, which, seeing that the crumbs brought birds, would occasionally hide herself behind some shrubs, and when the birds came for their breakfast, would pounce out upon them with varying success. The crumbs had been laid out as usual, one afternoon, but left untouched, and during the night a slight fall of snow occurred. On looking out next morning my friend observed Puss busily engaged scratching away the snow. Curious to learn what she sought, he waited, and saw her take the crumbs up from the cleared space and lay them one after another on the snow. After doing this she retired behind the shrubs to wait further developments. This was repeated on two other occasions, until finally they were obliged to give up putting out crumbs, as Puss showed herself such a fatal enemy to the birds.

GREENOCK

June 23

Aquarium Notes

Marine Copepoda—The lump-sucker.—In the salt water tanks of the Edinburgh Aquarium at the present date may be seen an immense number of white specks flitting rapidly through the water, after the fashion of the familiar *Cyclops* and its neighbours in fresh streams. On subjecting these "tenants at will" of the tanks to microscopic scrutiny, they are seen to belong to the Entomostracous division of the crustacea, and may in all probability be classified in the cyclops-family, as near kith and kin of the well-known "fresh-water flea." The cephalothorax

is well-defined, the body being flattened, whilst the posterior edges of the cephalothorax are prominent and somewhat hooked. The feet number five pairs, and are setose. No external ovisacs exist, and the antennæ are of simple conformation. Under the microscope the intestinal canal, filled with brownish matter, is seen to pulsate in rhythmical fashion. The abdomen is apparently composed of some four joints, and is terminated by two long caudal bristles. The eye is single, median, and red-coloured. In the absence of more definite characters, I should feel inclined to allocate the form near the genus *Alteutha*, of Baird, from the hooked character of the cephalo-thoracic edges. It differs from *Alteutha*, however, in the absence of the characteristic hooked edges of the fourth somite of the abdomen. The sudden appearance of myriads of these creatures in the tanks may probably be attributed to the recent favourable temperature; the eggs of the adults having lain dormant, as do the cyclops themselves, through the winter.

In the tanks are shown at present several large specimens of the lump-sucker (*Cyclopterus lumpus*). These fishes, as is well known, adhere by means of their sucker (formed by the modified ventral fins) to fixed objects. Watching a lump-sucker firmly attached to the glass of the tank, the idea occurred to me that the sucker may have been developed by natural selection, as a useful adjunct to the breathing-movements of the fish. When fixed, the fish appears to be perfectly at ease, and to breathe more fully and strongly than when swimming. The movements of the opercula, or gill-covers, when the fish was attached, were specially strong, as compared with their motion in the act of swimming. In a large-headed and heavy-bodied fish like *Cyclopterus*, any aid given to the respiratory movements would be a clear gain to the animal; and from a habit simply of resting on an object so as to afford leverage and play to the gills, the comparatively useless ventral fins may have become specially modified as a disc of attachment. The development of the sucking-disc and enlargement of the branchial cavity would thus proceed *pari passu*, and by natural selection the present exaggerated features of both organs would be attained. It would be interesting to know whether the history of cyclopterous development might or might not confirm these suggestions. The lump-suckers have spawned in our tanks, but unfortunately there has been no attempt on the part of the males to fertilise the ova.

Edinburgh, June 14 ANDREW WILSON

Snails *v.* Glow-worms

SOME years ago I brought three glow-worms from Wales to London, and at night I put them on the grass, when all showed their lights; but on looking for them a short time after, one had nearly disappeared, and on searching for it my hand came against something cold, and on taking it to the light I found it was a snail—one of those which just now are very common—about $1\frac{1}{2}$ inches long by $\frac{1}{4}$ inch diameter, and of a sandy colour. The brute had swallowed the glow-worm, and I could see the light shining inside!

As there are no glow-worms in this part of the country, I wish some one who has the chance would try the experiment again, by placing a glow-worm and a snail near to each other, and report the result. R. S. NEWALL

Ferndene, June 22

Oxygenated Rain

THIS morning I have read Mr. Solly's note on this subject. Yesterday, June 21, we had a thunderstorm, and while looking at the lightning I noticed that the rain falling on the window-glass had what I first thought were small particles of hail in the drops; but on magnifying it I found that the opacity was caused by a number of very small air-bubbles, which soon disappeared.

These drops fell during the shower, and only for an interval which I think did not exceed ten seconds, for I had only time to take the magnifier out of my pocket and observe a few drops, after which no more fell which contained air-bubbles.

One flash of lightning left a track which lasted about five seconds, and gradually faded. This was also observed by one of my family who was observing at a distance of 1,000 feet from where I was. R. S. N.

Butterfly Swarms

THE swarms of butterflies alluded to in NATURE, vol. xx. p. 183, have been observed in various localities of Switzerland—Lausanne, Morges, the foot of the Jura, &c. The passage lasted a long time, from one to four hours, on June 9; the species was *Vanessa cardui*. By comparing the hours and dates of the appearance in the various localities, I am convinced that it is simply due to the extraordinary local fecundity of this species, and not to a migration of butterflies from Africa or the shores of the Mediterranean, as various French and Swiss journals have supposed. F. A. FOREL

Morges, Switzerland, June 23

Meteor

I SAW a bright meteor at Bath last night. It flashed into sight at a spot some 10° to the south of Arcturus at 10.38 P.M. The duration of its visibility was between two and three seconds, the direction of its path very nearly north-east to south-west, its brilliancy quite that of one of the so-called "fire-balls" in pyrotechnic displays. It travelled through about 25° of arc, leaving a very faint trail, which however disappeared almost immediately. What struck me as particularly remarkable about the meteor was the decided bluish-green colour of its light.

June 19 C. ARMBRUSTER

JOSEPH WILSON LOWRY, F.R.G.S.

DEATH has just erased another well-known name from the roll of workers on the Geological Survey of Great Britain, that of J. W. Lowry, the eminent engraver whose maps, sections, and plates of fossils form so interesting a part of the records of this important branch of the scientific public service.

Joseph Wilson Lowry was the only son of Wilson Lowry, F.R.S., and Rebecca Lowry, well known as a mineralogist some seventy years ago; he was born October 7, 1803. His father was the leading architectural and mechanical engraver of his time, and he trained up his son to follow his own pursuits. From his early youth his father's house was the resort of men of high intellectual culture, and his mother's pursuits leading her also to associate with the scientific men of the day, what wonder that young Lowry early imbibed his parent's tastes and became an ardent lover of all natural history studies and pursuits, an accomplished draughtsman, and a well-informed scientific man.

His first practical effort was directed to the construction of a model in plaster of the Isle of Wight, geologically coloured, and divided transversely so as to give a section (also geologically coloured) through the centre of the island.

His pursuit of natural science led him early in life to become acquainted with John Phillips, at that time keeper of the Yorkshire Philosophical Society's Museum in York, and later on, when Assistant-General Secretary of the British Association for the Advancement of Science, or when associated with De la Beche on the Geological Survey, or when Professor of Geology in Oxford, until his death, Prof. Phillips remained the sincerely attached friend of J. W. Lowry.

Lowry's first important work as an engraver was the execution of the plates for the "Encyclopædia Metropolitana." He also executed for Sir John Rennie a series of plates of London Bridge. For many years Mr. Lowry prepared all the engravings for Scott Russell illustrative of wave-lines and the contours of ships. Mr. Lowry designed and executed numerous maps and charts for the Society for Promoting Christian Knowledge, the illustrations for Weale's Scientific Series, the atlas of maps published by the *Dispatch* newspaper, the first really cheap and good atlas ever produced.

The plates illustrating Phillips's "Geology of Yorkshire," and many other scientific works, were engraved by Mr. Lowry. We are also indebted to him for the excellent series of Natural History Charts of British Fossils, stratigraphically arranged, British Tertiary Fossils, Recent and Fossil Crustacea, by Dr. H. Woodward and J. W. Salter, &c. (Stanford's).

Hundreds of plates of fossils, exquisitely engraved, and maps and sections, too numerous to recount, published for the Geological Survey of Great Britain, amply testify to Mr. Lowry's rare ability as a scientific engraver. Even the familiar card-maps of each town visited year after year by the British Association were invented and produced by Mr. Lowry's skill and ingenuity.

But the days of engraving seem drawing to a close, at least so far as *printing* from engraved plates is concerned; but the beautiful plates prepared by Mr. Lowry cannot well be surpassed by modern lithography, save in cheapness.

Much as Mr. Lowry's work was valued by scientific men, his amiability of disposition and his modesty won for him even higher esteem among his friends. Many who knew him personally will recall his readiness on all occasions, even at great personal sacrifices, to help those who needed his assistance. His freshness of heart and kindness to young people were marked features in his character. He died on June 15. H. W.

DAVID MOORE, PH.D.

THE death of the Director of the Royal Botanical Gardens at Glasnevin, near Dublin, on June 9 last, has caused a very wide-spread sorrow among the botanists and horticulturists of Europe. Although Dr. Moore had attained the age of seventy-two, yet his physical strength was but little abated, and his mental powers were as strong as they were mature. A peculiarly severe attack of acute cystitis of scarcely four days' duration deprived us of a truly excellent and amiable man.

A native of Dundee, his father, attracted by the fame of Dr. MacKay, the Director of the Botanical Gardens belonging to the University of Dublin, and well known as the author of the "Flora Hibernica," sent David Moore to Dublin to be MacKay's apprentice. The apprentice soon learnt all the master had to teach, and was not long in qualifying himself to form one of the government staff, to whom, under the superintendence of the late General Portlock, was intrusted the Ordnance Survey of Ireland. This was in 1834; the Survey began in the County of Londonderry. In 1837 the first volume of its *Memoirs* was published, to which Moore contributed an essay on the flora of the region surveyed. Shortly after this he was elected by the then Council of the Royal Dublin Society to the charge of their Botanical Gardens at Glasnevin. These gardens are situated within a couple of miles of Dublin, and present a pleasing alternation of flat and gently rising ground, which then slopes to the borders of the little trout stream called the Tolka. They are associated with the memories of Tickell and Swift, and one walk amid old yew trees is still pointed out as the one much frequented by the Dean when inclined to moody meditation. To enumerate the changes brought about in these Gardens during the forty years' work of Moore, would be to write his and their history. It might almost be said that he found them a mixture of pleasure-ground and herb-garden; he has left them with all their native loveliness shown off to its very best, and containing for their size one of the best stocked collections in Europe. As the stranger walked there he was told of the literary men who sought for rest and quietness amid their shade; to the list of these sacred memories will now be added the name of a scientific man, whose daily labour for just forty years has resulted in making them known throughout the world. Amidst the practical labours of Moore's life science was not forgotten. He ably assisted MacKay in compiling his list of Irish plants. But he also devoted a great deal of attention to compiling a history of the mosses, liverworts, and algæ of his adopted country, and as the result of his maturer labours in this direction, he published in 1872 an account of the mosses of Ireland, and four years later an account of the Irish Hepaticæ. He, conjointly with A. G. Moore, F.L.S., published an account of the geographical distribution of plants in Ireland, under the title of "Cybele Hibernica." This is scarcely the place to record the numerous plants introduced by him to our gardens and stores, or to refer to the many interesting new hybrid forms brought into existence through his skill. For such scientific labours he was rewarded by being given the Ph.D. of Leipzig University, and with what we know he regarded as nearly as great an honour, in having the twenty-ninth volume of the third series of the *Kew Journal of Botany* dedicated to him by Sir Joseph Hooker, as "to one who, maintaining a very rich and beautiful botanic garden at a high standard of excellence, has advanced botanical science by many original observations and experiments."

Long will the memory of David Moore dwell in the minds of his many friends as that of one true and faithful, genial and generous.

THE RECENT ERUPTION OF ETNA

PROF. SILVESTRI has, with most commendable despatch, just issued his report to the Italian Government on the recent eruption of Etna. It takes the form of a quarto pamphlet of nineteen pages, entitled *Sulla doppia eruzione dell' Etna scoppiata il* 26 *Maggio*, 1879, and it is accompanied by a capital map, showing the exact extent and dimensions of the lava-streams. A reference to the map accompanying the previous article (p. 158) may help the reader to understand more clearly what follows.

At the end of our former article on the subject, we mentioned certain anomalies in the accounts of the eruption already transmitted by telegram from Rome, and at the same time asserted that we must wait for the Government Report before they could be explained. It is satisfactory to find that Prof. Silvestri has completely removed these anomalies, and has given a description of the eruption, which is so connected, reasonable, and precise, that it leaves nothing to be desired.

Silvestri considers that preparations for this eruption have been continued since 1874, and that this is the fulfilment of the abortive attempt which was then made. On August 29, 1874, a rift opened on the north-east side of the mountain, between the great crater and Mojo, and thirty-five small eruptive mouths were formed along its course, together with one larger crateriform monticule, which discharged lava. But after seven hours of activity, the dynamic forces suddenly decreased in intensity, and in two days' time nothing remained of the eruption save a few secondary manifestations. For a fortnight afterwards, however, earthquakes occurred on the north side of the mountain, and the great rift remained open. Silvestri predicted that when the next eruption came, this rift would prove the point of least resistance, and that the new lava would flow from it, or from craters raised along its course. This prediction has been completely verified.

The fissure of 1874 has extended itself—on the north-north-east towards Mojo, on the south-south-west towards Adernò. It is 10 kilometres (6·2 miles) in length, and passes through the great crater of Etna. On May 26, the south-western extremity discharged lava in the direction of Adernò while simultaneously the north-eastern extremity discharged lava in the direction of Mojo, thus presenting the curious anomaly of twin eruptions on opposite sides of the mountain. The craters on the south side of the mountain were situated near the base of Monte Frumento 2,650 metres (8,743 feet) above the sea. There were eight eruptive mouths, from 4 to 15 metres in diameter; seven of these were open, while over the eighth was raised a monticule. The lava did not flow directly towards Adernò, 13 kilometres distant, but towards a series of monticules formed during a previous eruption, and known as *Monti Grotta degli Archi*. It accumulated against the

first of these mounds, and then divided into two branches' one of which commenced to flow towards Adernò, and the other towards Biancavilla, but the supply died out at the source, and the new streams solidified at a height of 2,000 metres, having flowed for a mile and a quarter as a stream 400 metres in breadth. This stream did but little damage; it did not penetrate into the cultivated region, and but in short distance into the woody region. It came into contact, however, with a bed of snow, part of which it converted into clouds of steam, while another portion was liquefied and rushed down the sides of the mountain in a foaming torrent, carrying with it a good deal of *débris*.

The outflow of lava ceased on the south side of the mountain, because the lava found a vent at a lower level on the north side. As the one decreased in activity the other increased. On May 28th Silvestri visited the scene of the northern eruption. A great column of smoke appeared about 20° east of north, while a shower of sand descended, producing the "sad leaden light" (*la luce triste plumbea*) observable during an eclipse. More than two pounds of this sand were collected in ten minutes in an inverted umbrella, and the north flanks of the mountain were soon covered with it. Silvestri ascended from Randazzo towards the new craters, and when at a height of about 2,000 metres and near Monte Nero he heard loud subterranean detonations, and perceived severe oscillations of the soil. Soon afterwards he came upon the great rift, together with several smaller ones, converging towards the principal crater. In the immediate neighbourhood of Monte Nero and Timpa Rossa three new craters were seen, from one of which dense clouds of white smoke issued, while the others emitted lava and showers of ashes and incandescent stones. Frequent flashes of lightning issued from the smoke. The stream of lava near its source emitted a very bright light which, when viewed by a direct vision spectroscope, gave the lines of hydrogen, calcium, sodium, and potassium. The lava flowed downwards at a rapid rate: the wood of Collebasso was destroyed, and by the evening of May 29 it had flowed $6\frac{1}{4}$ miles, destroying the bridge of Passo Pisciaro and crossing the postal road between Randazzo and Linguaglossa. On Sunday the 31st the stream was rapidly approaching Mojo; the inhabitants became frightened, and brought out the figure of their patron Saint Antony, which was carried in procession to the edge of the stream, while the people fell on their knees and besought the Deity to save them from the impending danger. After the evening of June 1 the force of the eruption began somewhat to abate, and by the 6th inst. it was practically at an end. The lava stream ran nearly 7 miles from its source, and ultimately stopped 500 yards from the river Alcantara, and about half a mile from the village of Mojo. At its termination it is 23 feet in breadth and nearly 32 feet in height. The lava stream entered the bed of the Pisciaro torrent with a velocity of from 4 to 5 metres a minute, which was reduced to 2 metres a minute in the lower valley of less inclination. In 76 hours the lava flowed more than six miles from its source.

Indications of a disturbed volcanic condition were manifest last October, when powerful shocks of earthquake were felt in the territory of Mineo, Palagonia, Vizzini, Scordia, Militello, and Caltagirone. Mineo was the centre of disturbance, and here the shocks continued at intervals during the month of October. Loud subterranean noises were also heard at intervals. Two months later an eruption of mud and gas took place near Paternò, on the southern flanks of Etna. The mud was hot, salt, and petroleum-bearing (*fango salato termale petroleifero*), and its ejectment continued for several months. Towards the end of December last the whole eastern sea-board was visited by a strong shock of earthquake; and soon afterwards a great increase of smoke from the central crater of Etna showed that the dynamic activity of the mountain was unusually near the surface.

Even now we cannot regard the eruption as at an end Ten days after the cessation of the flow of lava telegrams from Rome (dated June 17) announced that the neighbourhood of Santa Venere and Guardia had been visited by repeated shocks of earthquake. A telegram on the following day announced that "an earthquake of great violence" had occurred near Aci Reale, destroying five villages. There is evidently a great deal of volcanic energy still pent up not far from the surface, and we must fear that before long a further outburst will relieve the imprisoned Titanic forces.

G. F. RODWELL

THE ELECTRIC DISCHARGE WITH THE CHLORIDE OF SILVER BATTERY[1]

II.

THE HISTORY OF A TUBE

No. 129, *Hydrogen*

WE now give an account of the very great variety of phenomena presented by the same tube charged with hydrogen, No. 129 (see Plate), under different conditions of exhaustion when used in connection with batteries of various potentials, and traversed by currents of different strengths.

This tube is 32 inches long and 1·6 inch in diameter, the terminals are a straight wire and a ring, about 1 inch in diameter, both of aluminium; it is furnished with a glass stop-cock at each end, as represented in Fig. 3. The glass stop-cocks are connected with the mercurial pumps (Alvergniat and Sprengel) and with the gas generator respectively, as shown in Fig. 5.

Tube 129, 5*th Charge of Hydrogen.*—A glow at both terminals was first seen when the pressure was 17·2 mm., 22,632 M,[2] with 8,040 cells, and great heat developed in the dark discharge near the middle of the tube. The spectroscope showed faintly the C and F lines.

Pressure 16·5 mm., 21,710 M, 8,040 cells. One luminosity like that on the right hand of Fig. 10, sho out from the positive and approached to within 6 inches of the negative, then receded back and disappeared.

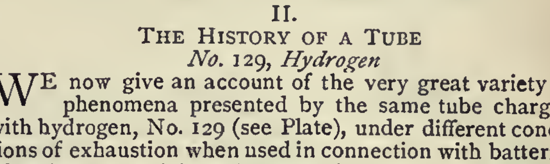


FIG. 10.

Pressure 15·8 mm., 20,789 M, 8,040 cells. 3 luminosities, very steady, which moved slowly and steadily towards the negative. The tube hottest in dark part where there was probably a non-luminous entity.

Pressure 14 mm., 18,421 M, with 6,840 cells, the current was unsteady, but it was perfectly steady with 8,040, and 6 arrow-headed luminosities like that on the left of Fig. 11, were produced and soon disappeared.

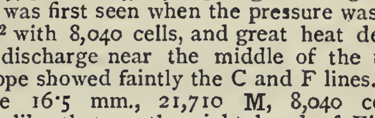


FIG. 11.

Pressure 10·3 mm., 13,552 M, with 8,040 cells. 8 luminosities something like 1, Fig. 12.

Pressure 9·4 mm., 12,368 M, with 8,040 cells. 12 luminosities like those, Fig. 7 in the Plate. The C and F lines seen in the glow around the negative.

Pressure 7·7 mm., 10,132 M, with 8,040 cells. 10 luminosities like Fig. 6 in the Plate; these ran together and disappeared and reappeared in a few seconds.

[1] Continued from p. 178.

[2] M = millionths of an atmosphere

Pressure 6·6 mm., 8,684 M, with 8,040 cells. 12 luminosities very similar to those shown at Fig. 5 in the Plate, the last adhering to the positive. The C line not visible in a nebulosity with the spectroscope, but that and the F line were both to be seen in the glow around the negative.

Pressure 5·9 mm., 7,763 M, 8,040 cells, C. 0·02056 W.[1] 13 luminosities like those Fig. 6 in the Plate. With 100,000 ohms, C. 0·01390 W, there were 10 luminosities not so wide as those when there was no resistance.

Pressure 6·1 mm., 8,026 M, 8,040 cells, C. 0·01910 W. At first 13 luminosities a little unsteady, then $11\frac{1}{2}$ per-

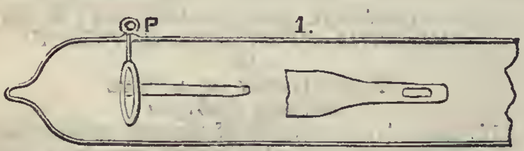


Fig. 12.

fectly steady, like Fig. 6 in the Plate. F and C visible in the glow around negative. F was not visible in a luminosity.

Pressure 4·4 mm., 5,789 M, 8,040 cells. 12 luminosities as depicted in Fig. 6 in the Plate, which is copied from a photograph[2] obtained in 4 seconds.

Pressure 4·0 mm., 5,263 M, 8,040 cells. 15 luminosities as shown in Fig. 7 in the Plate, from a photograph taken in 4 seconds.

Pressure 3·6 mm., 4,737 M, 8,040 cells, 30,000 ohms resistance. 15 luminosities almost touching, like Fig. 7 in the Plate.

Pressure 3 mm., 3,947 M, 4,800 cells, C. 0·0362 W, the resistance of the tube being 88,600 ohms. There were 24 steady blue strata and a space of about 6 inches con-

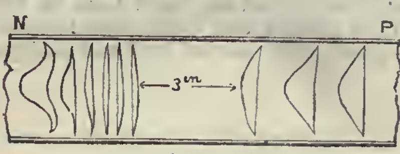


Fig. 13.

fused towards the positive; with 200,000 ohms resistance in the circuit the strata became pink, the current being 0·01469 W.

Pressure 1 mm., 1,316 M, 3,600 cells, C. 0·03896 W, the resistance of the tube being 59,170 ohms. The tube was filled to within one inch of the negative with strata all blue, but they turned pink and tongue-shaped when 200,000 ohms resistance was introduced, which reduced the observed current to 0·00782 W. The C and F lines visible in the luminosities. When 7,590,000 ohms resistance was introduced, a very close and somewhat agitated pink stratification was produced, like the left of Fig. 13.

Some gas let in, pressure 3 mm., 3,947 M, 3,600 cells gave a current of 0·04901 W; the resistance of the tube was ascertained by substituting 47,000 ohms wire resistance, which produced the same deflection. The strata were blue, like those of 55 and 56, Fig. 14. For about 10 inches from the negative they took up an axial backwards and forwards steady rotation of about a quarter turn.

With 174,000 ohms resistance, making with the battery and tube a total of 261,000, the current measured was 0·00879 W. The strata turned pink and assumed the tongue-form, Fig. 15; with 783,000 ohms in circuit very close strata. In the rotating mirror a flow *towards the positive* was observed until a break occurred in the stratification; the flow was then irregular and backwards and forwards.

Pressure 1·7 mm., 2,237 M. The current of 2,400 cells passed; with 3,600 cells the current was 0·03858 W, producing perfectly steady strata, of which a photograph was obtained in four seconds; a facsimile of it is given, Fig. 8 in the Plate. The strata were blue, but on introducing 500,000 resistance the current was reduced to 0·00175 W, and the strata turned pink and assumed the form Fig. 9 in the Plate, which is a facsimile of a photograph obtained in 19 seconds.

Pressure 0·8 mm., 1,052 M, 3,600 cells (C.) 0·19940 W. A spiral series of tongues depicted in Fig. 10 in the Plate, from a photograph which, however, could scarcely be exposed long enough in consequence of the screw-like motion of the tongues. This motion appeared to be from positive to negative.[1] On introducing 900,000 ohms resistance, (C.) 0·003414 W, the tongues grouped themselves in pairs, of which there were 40, and changed from blue to pink. Examined with the spectroscope, the line C had disappeared. The tube was connected with the condenser of 42·8 microfarads and 3,240 cells, a resistance of 200,000 ohms being in circuit (C.) 0·007461 W. At the full potential the same spiral series of blue tongues, quite steady, was produced, and these made a complete rotation in 30 seconds. On breaking connection between the battery and condenser, the strata gradually changed to pink as the charge of the condenser ran down through the tube.

Tube 129, 6th Charge of Hydrogen.—The tube, at 0·9 mm., 1,184 M, was partially charged with hydrogen by letting in 4 small calibrated charges, which increased the pressure each time 1·4 mm., pressure 6·5 mm., 8,684 M, the resistance of the tube was found to be 170,000 ohms, and the total resistance of the whole, 8,040 cells, 130,000 ohms, or an average of 16·6 per cell. With 6,960 cells the current, through the tube alone, was 0·02456 W, and there were produced 9 luminous entities as shown in Fig. 5 in the Plate, taken from a photograph obtained in $1\frac{1}{2}$ second.

The gas in the tube at the same pressure, namely,

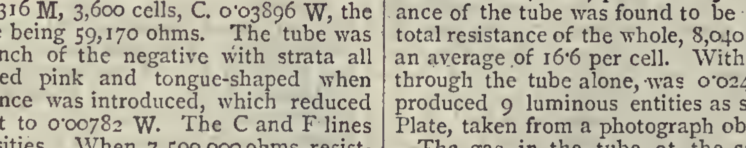


Fig. 14.

6·5 mm., 8,040 cells, C. 0·02634 W. There were 7 entities as depicted in Fig. 4 in the Plate, copied from a photograph obtained in one second.

Pressure 6·5 mm., on the introduction of 300,000 ohms resistance with 8,040 cells, C. 0·0138 W, making a total resistance, inclusive of the tube and the battery, of 600,000 ohms, two luminosities were produced as seen in Fig. 2 in the Plate, taken from a photograph obtained in 2 seconds, which, however, had to be corrected from a drawing, as there was a slight movement in the luminosities.

Pressure 3·6 mm., 4,737 M, 4,800 cells. Strata resembling Fig. 16, but near the negative the strata were

[1] C denotes currents; W webers.

[2] Varley, C. F. (*Proc.* Roy. Soc., xix., 1871, pp. 238–239) succeeded in photographing by an exposure of thirty minutes an *arch discharge* in a vacuum tube, so faint that in a perfectly dark room he was "sometimes unaware whether the current was passing or not."

[1] De la Rive (Genève *Mém.* Soc. Phys. xvii., 1863, p. 72) describing the appearance of a nitrogen tube, says: "Ces stries semblent former une hélice animée d'un mouvement de rotation autour de son axe."

indistinct. In the rotating mirror the distinct strata were steady, but in the indistinct portion there was indicated a rapid flow *towards the positive*. The lines C, F, and G seen in the glow around negative terminal, but C and G were not seen in the strata.

Pressure 1·2 mm., 1,579 M, 2,400 cells, C. 0·03251 W. 11 narrow strata, umbrella-shaped, about $\frac{3}{8}$ of inch wide, followed by two about $1\frac{1}{4}$ inch wide, then a confused discharge, in which the rotating mirror showed a rapid flow *towards the positive*. C, F, and G lines visible in

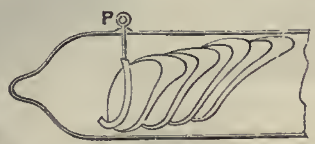


FIG. 15.

the negative glow; G and C disappeared in the strata, and F was very faint.

Tube 139, *Hydrogen*.—Pressure 6·319 mm., 8,314 M, 8,040 cells. Three arrow-headed luminosities as depicted in Fig. 3 in the Plate, copied from a photograph and a drawing made at the time. The photograph was obtained in 2 seconds.

Pressure 9·502 mm., 12,526 M, 6,960 cells. One luminosity of which a photograph was obtained in 10 seconds but has not been copied. Another photograph obtained

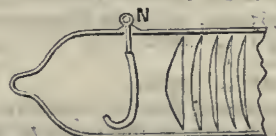


FIG. 16.

in 1 minute is shown in Fig. 1 in the Plate, it will be observed that it has a spear-head continuation towards the negative.

Pressure 0·051 mm., 67 M, the current of 3,600 cells passed intermittently; 4,806 cells, C. 0·00191 W, produced a continuous illumination from the positive to within 3 inches of the negative, the discharge at the negative licking the inside of the tube.

Pressure 0·01 mm., 13 M, the current of 4,800 rod cells just passed: with 6,960 cells the current produced no appreciable deflection of our galvanometer which would indicate 0·00024 W. The strata thickened and became much wider. The discharge at the negative licked the side of the tube and was very sensitive to the approach of the finger.

By standing 16 hours the pressure had somewhat increased without leakage having occurred, and was 0·037 mm., 49 M, 6,960 cells, current less than 0·00024 W; the discharge was milky white and quite different from anything before seen by us with a hydrogen residual charge. The strata had become still broader, the negative discharge hugging the tube and being very sensitive to the finger. The C and F lines could not be seen with the spectroscope, but there was a double green line near *b*.

A charge of hydrogen was let in, the charge being 0·001725 of the capacity of the tube and pump, and increased the pressure to 1·311 mm., 1,725 M. 3,600 rod cells produced a stratification composed of umbrella-shaped strata, united in the middle of the tube by a luminosity one-third the length of the tube. The double green line near *b* had disappeared, and the C, F, and G lines were visible in the spectroscope.

Another calibrated charge of hydrogen was let in and raised the pressure to 2·622 mm., 3,550 M; the current of 3,600 cells just passed: with 4,800 cells a phase was produced resembling tube 129, Fig. 7 in the Plate.

Another most interesting tube was a favourite of our friend the late Mr. Gassiot, and was presented by him, with many others, to Mr. Spottiswoode. It retains, in a remarkable degree, the record of old stratification by bands of dark deposit with clear spaces between them. It was a matter of interest to ascertain whether the lines of deposit coincided with the position of the spaces or with that of the strata. This tube is composed of a cylinder 13 inches long, and $1\frac{3}{16}$ inch in diameter, having at one end a bulb 2 inches in diameter, from which project at right angles to the main tube two short lengths of tube $1\frac{1}{3}$ inch in diameter, the whole resembling in form the letter T. At the end of the tube opposite the bulb is a straight brass wire $\frac{1}{16}$ inch in diameter screwed on to a wire of platinum, and in the head of the T a brass wire, $4\frac{3}{4}$ inches long, reaching axially right across. The bulb and short tubes attached to it are completely coated with a dense black metallic deposit, and for a space of 5 inches from the bulb, the main tube is stained with eight dark bands. 2,400 cells gave a current 0·02289 W, the straight wire being positive, and the cross wire in the bulb

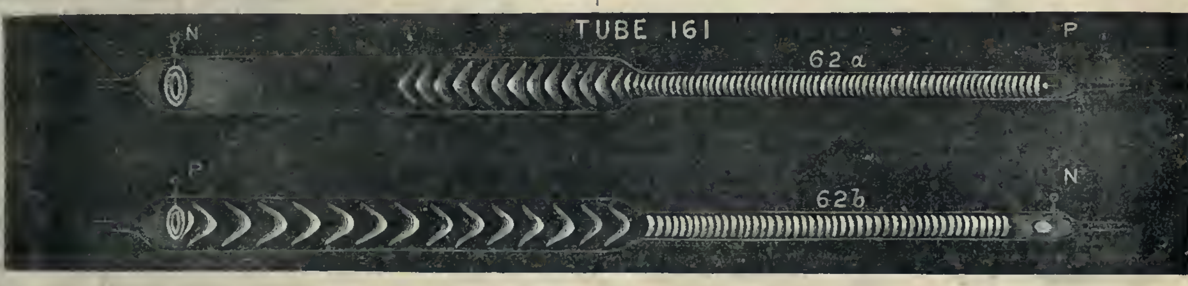


FIG. 17.

negative; there were produced beautiful double strata intensely blue, completely filling the tube. Strips of paper were fastened over these strata in the region of the stains; these were found to occupy the *unstained spaces*; the stains therefore marked the *intervals*, or cooler parts, between former strata.

Tube 161, *Hydrogen*.—The difference of the strata in tubes of different diameter at the same pressure and with the same current is very clearly brought out in tube 161, composed of two portions, one being 18 inches long and 1·65 inch internal diameter, the other 17·5 inches long, and 0·975 inch diameter, the ratio of the sectional areas being 2·864 to 1. The terminal in the small tube is a point, in the large one a ring.

With 4,800 cells, the point (small tube) positive C. 0·02825 W, there were produced in the small tube 62 disk-shaped strata, and in the large tube twelve cup-shaped strata occupying half of the length of the large tube; beyond these the discharge was dark. With the point negative, C. 0·02451, there were produced in the small tube 54 disks, and in the large tube thirteen cup-shaped, completely filling it. The number of strata does not, therefore, appear to be in the inverse ratio of the areas. The strata in the small tube were blue, but

at times, with a large current, carmine, as in the capillary part of a spectrum-analysis hydrogen-tube, the strata in the large tube being much fainter and pink. The appearance when the point was positive is shown in the diagram, Fig. 17, 62*a*, and when negative in 62*b*, copied from photographs obtained, the former in 15 seconds, the latter in 10 seconds. Another example is shown in Fig. 12 in the Plate.

Tube 160, *Hydrogen.*—This tube was constructed with the object of sending the analogue of a smoke ring through a tube in which a steady stratification had been procured and sustained; Fig. 18 shows the arrangement.

The tube is 40 inches long and 1·875 inch in diameter, and has a stop cock at each end; near one of the ends is a small tube, 0·75 inch in diameter, sealed to the main

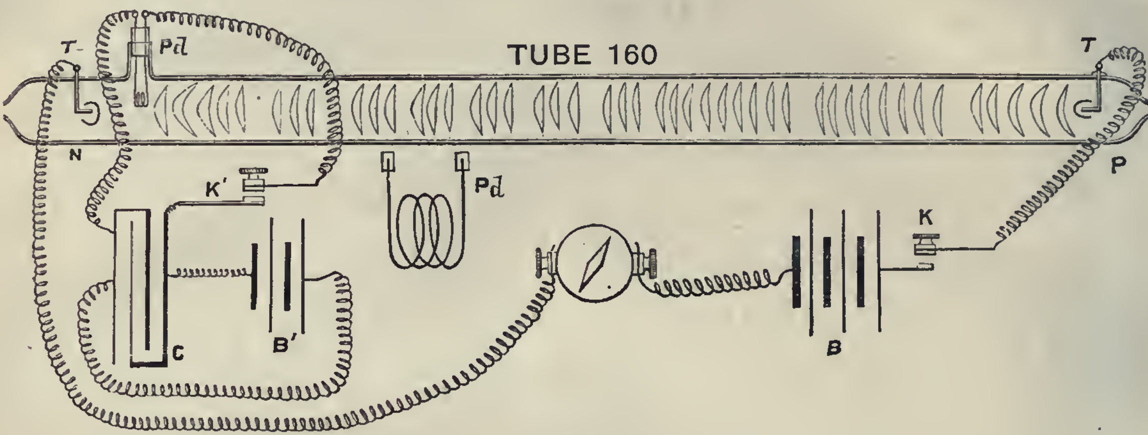


FIG. 18.

tube at right angles, and fitted with a glass stopper, in which two stout platinum wires, 0·043 inch diameter, are melted; there is soldered, with gold, to the two platinum wires a spiral of palladium made of wire 12 inches long and 0·0125 inch diameter, P*d*, in the diagram. The palladium coil was charged to saturation with hydrogen, by immersing it in dilute sulphuric acid and making it the negative pole of a bichromate battery of six elements; after it had been washed in distilled water it was dried and inserted in the tube. The two stout wires of platinum, to which the palladium coil is attached, are connected to a condenser of 10·9 m.f., charged with 3,240 cells. One of the wires leads to the key K′, so that no current can pass from the condenser until this key is pressed down; when this is done the charge passes, and by suddenly gniting the wire drives off the hydrogen.

4,800 cells without external resistance:—

Pressure 0·9965 mm., before the discharge of the condenser,
,, 1·0381 ,, after ,, ,,

Difference 0·0416 ,, 55 M,

strata were produced from the positive up to the palladium coil which was on the negative side. On liberating hydrogen by the discharge of the condenser these were driven back 14 inches towards the positive, and subsequently only a confused discharge was produced.

When the terminal near the coil was positive the same phenomena were not produced on the discharge of the condenser.

In order to test whether it would be possible to render evident pulsations in the current when perfectly steady strata are produced in tubes containing residual gases, we arranged the detector apparatus as shown in Fig. 19.

A Z is the battery; A being connected through the fluid resistances F R, F R′ (which can be plugged out of circuit by means of P and P′), the megohm wire resistance, and the primary of Apps' induction-coil No. 819, to the terminal T′ of the tube; the terminal A is also connected direct to one plate of the condenser C. Z is connected through the key K to the fluid resistance F R″ (which can be plugged out by pressing down the key K′), thence to the other plate of the condenser, and through the safety-wire to the other terminal T of the tube. The secondary wire of coil 819 is connected to a delicate Thomson galvanometer T.

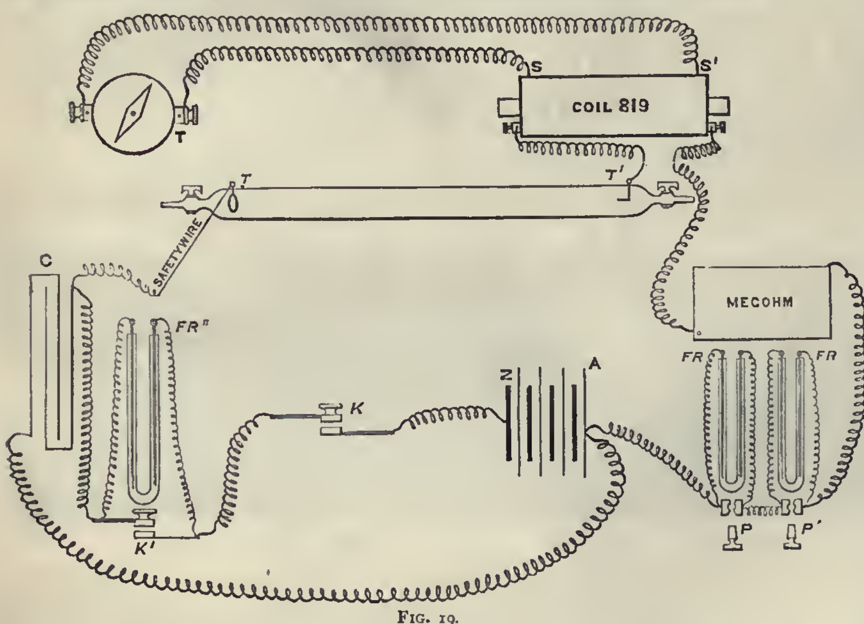


FIG. 19.

Many observations were made with coil No. 819, which we had taken to pieces several times during the course of our trials, on account of suspected leakage from the

primary to the secondary wire. It was ultimately entirely remade in February, 1878, and the secondary wire coiled on a separate ebonite cylinder to insure efficient insulation, which was accomplished.

In every case where the strata are to the eye or rotating mirror perfectly steady, slight deflections of the needle are seen; these generally indicate a resultant *direct* current (break-contact), and in the fewer number of cases an *inverse* current indicating, in the first case, a *sudden* decrease and *slow* increase of current through the tube. These deflections, though very manifest, do not amount to more than about three or four divisions of the galvanometer scale, a deflection which indicates a current of only 0·0000000023 W. At the advent or retreat of a stratum at the positive pole there is frequently produced a deviation of 300 divisions, indicating a current of 0·00000001812 W; before a stratum leaves the positive terminal or dies out on it, there is usually a tremulous motion of that stratum visible to the eye and indicated by rapid pulsations of the galvanometer.

On the suggestion of Prof. Clerk Maxwell we have recently introduced the telephone into the primary current, as shown in Fig. 20, and also in the secondary current of coil 819.

In all cases where the condenser C was discharging itself gradually through the tube, a low rustling sound was distinctly audible to sensitive ears so long as the stratification remained *apparently* perfectly steady. When the phase of confused stratification which immediately precedes extinction was reached, the sound in the telephone became very loud and rose in pitch, with some tubes becoming quite shrill. These results, therefore, confirm the conclusion already arrived at from other experiments, namely, that the discharge in vacuum tubes is intermittent; but we do not pretend that they make it manifest that stratification is *dependent* upon intermittence.

In the course of our experiments, using sometimes 11,000 cells, we have arrived at the following facts:—

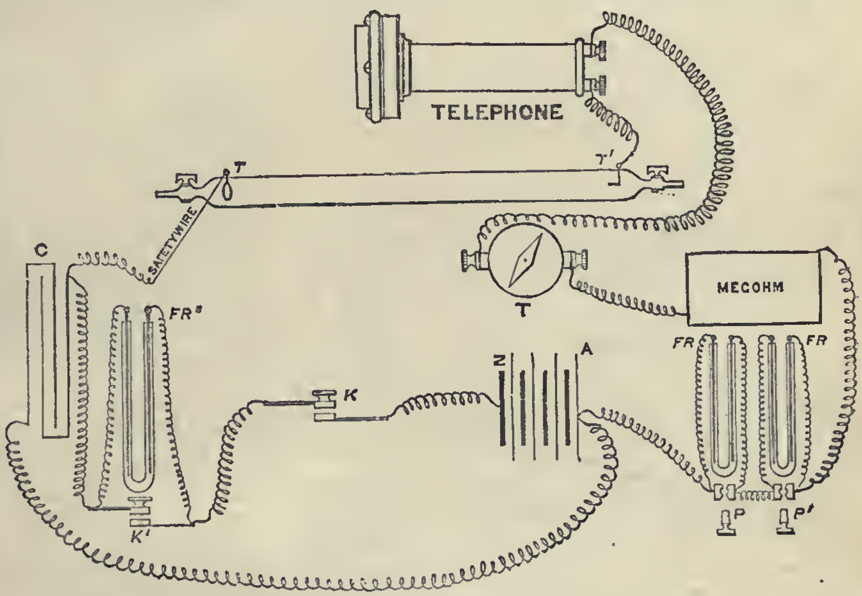


FIG. 20

1. *The discharge in a vacuum tube does not differ essentially from that in air and other gases at ordinary atmospheric pressures; it cannot be considered as a current in the ordinary acceptation of the term, but must be of the nature of a disruptive discharge, the molecules of the gas acting as carriers of electrification. The gases in all probability receive impulses in two directions at right angles to each other, that from the negative being the more continuous of the two. Metal is frequently carried from the terminals and is deposited on the inside of the tube, so as to leave a permanent record of the spaces between the strata.*

2. *As the exhaustion proceeds, the potential necessary to cause a current to pass diminishes up to a certain point, whence it again increases, and the strata thicken and diminish in number, until a point is reached at which, notwithstanding the high electromotive force available, no discharge through the residual gas can be detected.* Thus, when one pole of a battery of 8,040 cells was led to one of the terminals of tube 143, Fig. 21, which has a radiometer attached to it, the other terminal of the tube, distant only 0·1 inch, being connected through a sensitive Thomson galvanometer to the other pole of the battery (earth), the current observed was not greater than that which was found to be due to conduction over and through the glass. Although no current passed, the leading wires acting inductively stopped the motion of the radiometer, as has been observed by Sir William Grove.

3. *All strata have their origin at the positive pole.* Thus, in a given tube, with a certain gas, there is produced at a certain pressure, in the first instance, only one luminosity which forms on the positive terminal, then, as the exhaustion is gradually carried further, it detaches itself, moving towards the negative, and being followed by other luminosities, which gradually increase in number up to a certain point.

4. *With the same potential the phenomena vary irregularly with the amount of current.* Sometimes, as the current is increased, the number of strata in certain tubes increases, and as it is diminished their number decreases; but with other tubes the number of strata frequently increases with a diminution of current. If the source of the current is a charged condenser, the flow being from one of its plates through resistances and the tube to the other; then, as the potential of the condenser falls and the current diminishes, the number of strata alters; if the strata diminish in number with the fall of potential, then the stratum nearest the positive wire disappears on it, the next then follows and disappears, and so on with others; if, on the other hand, the charge of the condenser is very gradually increased, the strata pour in, one after the other, in the most steady and beautiful manner from the positive.

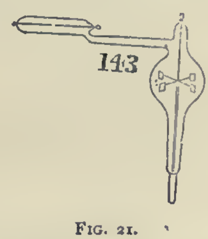


FIG. 21.

5. *A change of current frequently produces an entire change in the colour of the strata:* for example, in a hydrogen tube from a cobalt blue to a pink. It also changes the spectrum of the strata; moreover, the spectra of the illuminated terminals and the strata differ.

6. *If the discharge is irregular and the strata indistinct, an alteration of the amount of current makes the strata distinct and steady.* Most frequently a point of steadiness is produced by the careful introduction of external resistance; subsequently the introduction of more resistance produces a new phase of unsteadiness, and still more resistance another phase of steady and distinct stratification.

7. *The greatest heat is in the vicinity of the strata.* This can be best observed when the tube contains either only one stratum, or a small number separated by a broad interval. There is reason to believe that even in the dark discharge there may be strata, for we have found a development of heat in the middle of a tube in which there was no illumination except on the terminals.

8. *Even when the strata are to all appearance perfectly steady, a pulsation can be detected in the current; but it is not proved that the strata depend upon intermittence.*

9. *There is no current from a battery through a tube divided by a glass division into two chambers, and the tube can only be illuminated by alternating charges.*

10. *In the same tube and with the same gas, a very great variety of phenomena can be produced by varying the pressure and the current. The luminosities and strata, in their various forms, can be reproduced in the same tube, or in others having similar dimensions.*

11. *At the same pressure and with the same current, the diameter of the tube affects the character of the discharge and the form and closeness of the stratification.*

THE ROYAL SOCIETY OF EDINBURGH

THE goodly volume of the proceedings of this Society for the session 1877-78 witnesses to the zeal and success with which scientific problems, whether of general or of more specially local interest, are attacked by our northern *savants*.

The fascination in which the public mind has been held by those remarkable instruments, the telephone, phonograph, and microphone, here matures in fruitful study of them. Prominent among the researches referred to are those of Prof. Fleeming Jenkin and Mr. Ewing on the wave-forms of articulate sounds, as obtained from the phonograph (already described in our columns), and the thoughtful investigations of Dr. Ferguson on the indications of molecular action in the telephone, leading to the conclusion that at the sending-station the evidence of molecular action, though suggestive, is by no means conclusive, whereas at the receiving-station, the existence of molecular as well as mechanical action amounts to demonstration, and it is shown to be considerable in amount. Several striking observations in the same field are recorded by Professors McKendrick, Tait, and Forbes, Mr. Blyth, and others. In a paper on beats of imperfect harmonies, Sir William Thomson develops the theory of the phenomenon, and affirms (as a result of experiment) that in every case the ear distinguishes the two halves of the period of each beat, represented respectively by a sharp-topped and flat-hollowed curve and by a flat-topped and sharp-hollowed curve.

The Fourth Report of the Boulder Committee communicates many instructive facts, especially as regards transport of boulders. In his appended remarks Dr. Home shows reason for thinking that two notable spherical balls of marcasite found in the boulder clay at Leith, came from the westward, one from Campsie or Kilsyth (not less than thirty miles), the other from Humbie, nine or ten miles due west of Edinburgh. A geological study of the district indicates the agency of deep-sea currents loaded with ice, which flowed upon the Campsie Hills from the west-north-west, scooping out the present valley and breaking up, to a large extent, the coal strata in it. Thus some of the nodules in these strata would find their way to Leith, where they were embedded Several cases are noted in which boulders, to reach their present sites, must have crossed arms of the sea (*e.g.*, boulders in Staffa, at Appin, and in Loch Creran, from Mull, and others in Nairn, from Ross-shire). The high position of many boulders is explained by Prof. Judd's supposition, that in pliocene times there were mountains in Skye, Mull, Ardnamurchan, and even in Rum, some of which reached a height of at least 14,000 feet. In another geological paper Prof. Geikie traces out the limits of the different basins in which the old red sandstone of the British Islands was deposited, distinguishing the basins as Lakes Orcadie, Caledonia, Cheviot, Lorne, and the Welsh Lake. Dealing with the first alone, he examines the evidence for Murchison's three-fold arrangement of the old red sandstone (finding the middle division only in the north of Scotland), and describes the various districts of Lake Orcadie *seriatim*.

From experiments on suspension, solution, and chemical combination, Mr. William Durham concludes that these phenomena differ only in degree, and are manifestations of the same force. The attraction of chemical affinity is not, in all cases at least, exhausted when a definite compound is formed, but has sufficient power left to form solution or suspension compounds. The same force operating in chemical combination and solution, explains the powerful effects of solution in promoting chemical reaction and electric conductivity. Among chemical subjects treated, are the action of heat on some salts of trimethyl sulphine (Brown and Blackie), the action of chlorides of iodine on acetylene and ethylene (McGowan), and the crystallisation of isomorphous salts (Robinson).

In physiology, we note an extension of Prof. Rutherford and Messrs. Vignals' experiments on the biliary secretion, with reference to the action of cholagogues. The effects of fifty-two medicinal agents on the liver (of dogs) have been investigated, and the great majority of the conclusions are in complete harmony with the results of clinical observation, while many new facts are given to the physician.—Mr. Newman successfully imitates in a physical experiment, the function of the kidney.—Mr. Stirling furnishes some notes of the fungus disease affecting salmon.

A sketch is given by Mr. Edward Lang, of the arrangement of tables of ballistic curves in a medium resisting as the square of the velocity, and of the application of these tables to gunnery.

Without further enumeration, we may direct attention to some interesting accounts of that rare phenomenon, a white sunbow, witnessed at Edinburgh on January 10 last year.

OUR ASTRONOMICAL COLUMN

THE SATURNIAN SATELLITE HYPERION.—Prof. Asaph Hall has investigated the elements of this satellite, first from thirty of the best observations made at Washington in 1875, and again from thirty observations by Mr. Lassell at Malta, in 1852-53. In the former case the approximate elements in *Astron. Nach.* No. 2137 were used in the calculation of equations of condition, which were solved by the method of least squares. The resulting orbit is as follows:—

Passage through perisaturnium, 1875, Oct. 27·8380 Greenwich M.T.

Perisaturnium	$172^\circ\ 59'{\cdot}7$	For 1875,82. Referred to the plane of the earth's equator.
Ascending Node ...	$120\ \ 12{\cdot}0$	
Inclination	$6\ \ 12{\cdot}1$	
Excentricity	0·11885	
Semi-axis major	$216''{\cdot}56$	

Assuming these values for the node and inclination, Mr. Lassell's observations were discussed and gave the elements:—

Passage through perisaturnium, 1852, Nov. 17·5208 G.M.T.

Perisaturnium	... ...	240° 10′·9
Excentricity	... ...	0·12011
Semi-axis major	...	217″·05

It will be seen that the position of the perisaturnium had undergone a great change in the interval between the above epochs: the rapid motion of the line of apsides has been known for some time past to those who have attempted the determination of elements of Hyperion. Prof. Hall had at first supposed this motion direct, but he now adopts the smaller retrograde motion, and so finds for the motion of the line of apsides in a Julian year,—2°·92862. If we assume that 394 revolutions of the satellite had been performed in the interval between the epochs (8379·3172 days), the anomalistic period is found to be 21·2673026 days.

Prof. Hall thinks that the next step must be the calculation of the action of the great satellite Titan on the motion of Hyperion, a work which he hopes to be able to undertake. Not only is there a near approach of the orbits of the two bodies, but it would appear that Hyperion is moving in a larger orbit, than would correspond to the assigned period and Bessel's mass of Saturn. There is a probability that the approximation of the two satellites may be, at certain times, very close indeed. If we bring up Bessel's elements of Titan to 1875, and compare them with the above elements of Hyperion for the same year, we find an exceedingly near approach of the two bodies, when the position of the perisaturnium of Hyperion corresponds to that of maximum distance of Titan, and though uncertainty in the elements may affect the result, it is sufficiently evident that the motion of Hyperion cannot be followed satisfactorily without a knowledge of the action of Titan. Prof. Hall remarks that in 1882 it may be possible with the Washington refractor to follow Hyperion completely round its primary, as was done by Mr. Lassell at Valetta in 1852, and that from that time until 1888 it should be carefully observed.

THE OXFORD UNIVERSITY OBSERVATORY.—The report of the Savilian Professor of Astronomy, as Director of the University Observatory at Oxford, has been issued, for the year ending on the 4th of the present month. The $12\frac{1}{4}$ inch refractor has been in constant use in the determination of accurate positions of about 40 stars in the Pleiades, partly with the view of ascertaining the proper motions by comparison with the observations of Bessel half a century ago, and partly with the intention of comparing the micrometrical measures with those of the costly heliometer. The results will appear in Part II. of the Oxford Observations, and we may remark that the Savilian Professor will have a recent standard for comparison in M. Wolf's elaborate work on the Pleiades, (*Description du Groupe des Pleiades* in the Paris *Annales*, t. xiv.), to which he has not made allusion in the report. The De la Rue reflector has been employed in taking photographs of the moon, and nearly three hundred have been secured. With the view of ascertaining how far these photographs can be relied upon for accurate measurements, micrometrical measures of the shadows of several prominent lunar mountains were made with the refractor, simultaneously with the taking of photographs with the reflector; the latter being then measured in the De la Rue engine, it was found that the telescopic and photographic results were in close accordance, indeed within the limits of the unavoidable errors of observation. The Professor adduces a still further proof of the reliability of celestial photography in this direction, in the close accordance of the moon's semi-diameter, as measured and computed from sixteen of the Oxford photographs with Hansen's value adopted in the *Nautical Almanac*; the difference is only 0″·12. Amongst the other miscellaneous work of the Observatory during the past year, the periodical comets of Tempel (1873 July) and Brorsen have been well observed. In the Lecture Room discourses have been delivered on the Astronomy and Astronomical Instruments of Ptolemy and Hipparchus, on the Physical Libration of the Moon and on Solar Physics.

The obligation under which this institution remains to the great liberality and scientific spirit of Dr. De la Rue is well known. The salary of the photographic assistant has been defrayed by him during a period of four years, this subsidy, a most important one to the rising Observatory, terminating in December next. The necessary provision for the future effective conduct of the Observatory is under the consideration of the University Commissioners, subject to the final judgment of Convocation. It is suggested by the Savilian Professor in his report, that for the next few years a sum of 600*l.* annually may suffice to cover all necessary expenses. The desirability of an early publication of results, in the actual state of Astronomical Science, appears to be fully appreciated in the Oxford establishment: part I. of the Observations containing the work to December 1877 was published in the spring of 1878.

A NEW COMET.—A pretty bright telescopic comet was detected, apparently on the 16th inst., by Mr. Lewis Swift, of Rochester, N.Y. Prof. Winnecke observed it at Strasburg on June 21, and found its position at 11h. 38m. 46s. mean time in R.A. 2h. 47m. 31·1s., Decl. 64° 29′ 5″; daily motion in R.A. trifling, that in Decl. about one degree towards the north; diameter about three minutes.

GEOGRAPHICAL NOTES

AT the meeting of the Royal Geographical Society on Monday evening, after a feeling allusion by the Earl of Northbrook to the loss sustained by the Society by the death of Mr. R. B. Shaw, British Resident at Mandalay, who was well-known for his excellent geographical work in Eastern Turkistan, &c., some reports were read which had recently been received from Mr. Keith Johnston, the leader of the East African Expedition. The first was an exceedingly interesting account of his preliminary trip from Zanzibar to the Usambara Hills, and the second was a memorandum of information obtained regarding routes between Dar-es-Salaam and the north end of Lake Nyassa. It is no exaggeration to say that the latter document contained more real geography than many travellers contrive to collect in the course of a long journey, and it confirms the impression that Mr. Johnston, if he be spared, will, on his return from the interior, furnish us with a most admirable and accurate account of the country traversed, the greater part of which is at present absolutely unexplored. The Secretary afterwards read letters from Mr. Johnston and Dr. Kirk, H.M.'s Consul-General at Zanzibar, announcing the final start of the expedition for the interior, under the most favourable circumstances. Mr. Johnston has with him one European assistant and 138 porters, who have been carefully selected with the aid of Chuma, Livingstone's old follower, who also accompanies the party.

THE last sitting of the Geographical Society of Paris, was devoted to a lecture given by M. Cosson to prove (1) that M. Roudaire's contemplated Algerian sea would not improve the climate of the Sahara; (2) that in case any alteration were possible it would be detrimental to the health of the inhabitants; (3) that it would create dissatisfaction amongst the Tunisian and Algerian tribes, and even Algerian colonists; and (4) that it would have no effect in attracting to Algiers the trade of the Soudan. Commander Roudaire not having been invited to answer the charges proffered against his scheme the discussion was adjourned, but several members warmly protested against the assumption brought forward by M. Cosson, and tried to rebut his assertions.

CAPTAIN R. H. NAPIER, R.N., has communicated some useful hydrographic notes to the Hong Kong

Government Gazette respecting the Chinese island of Hainan and the Gulf of Tongking. The following are the positions determined:—Hoihow Fort A, lat. 20° 3′ 13″ N. long. 110° 19′ 3″ E.; Pakhoi Customs flagstaff lat. 21° 29′ N. long. 109° 6′ 6″ E.; Guie-chow Island summit lat. 20° 1′ 15″ N., long. 109° 6′ 31″; Cape Cami lat. 20° 11′ 58″ N., long. 109° 54′ 57″ E.; North Taya Island, lat. 19° 58′, N., long. 111° 16′ E.

IT is stated that Major Serpa Pinto will come to London soon to give a lecture on his recent journey across Africa.

SIR SAMUEL BAKER, who has spent the last six months in traversing the island of Cyprus in a gipsy waggon, carefully observing all the natural phenomena, is engaged in writing a book to be called "Cyprus as I saw it in 1879," which will be published by Messrs. Macmillan and Co.

THE newly published *Bulletin* of the Belgian Geographical Society contains two papers by their indefatigable vice-president, Colonel Adan, one of which is entitled "Sur la Participation des Officiers aux grands Travaux de Géographie Scientifique." M. Greiner contributes some notes on the cultivation of tobacco. We are glad to observe that considerable space (upwards of 29 pp.) is devoted to "Chronique Géographique," and much care is evidently bestowed on the collection of matter. Among these notes there is one of much interest on the proposal for connecting Liége and Escaut by means of a canal.

THE ever-interesting *Monatschrift für den Orient* for June contains several papers of varied interest. Georg v. Gyurkovics writes on the trade politics of Bulgaria; Dr. G. Schweinfurth sends from Cairo some notes on Rohlf's last exploring journey in Tunisian territory. In view of the new relations of Germany with the Samoan Islands, Dr. Hubbe-Schleiden's article on Germany in the Pacific is well-timed, and so from another point of view is Herr Josef Hras's letter from Shanghai on the Kulja Question. Under the title of Tsin and Ta-Tsin Count Schweiger-Lerchenfeld contributes a learned paper on the old trade routes of the Chinese.

THE principal paper in the June number of Petermann's *Mittheilungen* is a long account by M. A. Woeikoff of his travels in Yucatan and the south-east provinces of Mexico in 1874. As might be expected from so accomplished and experienced a traveller, the paper is very comprehensive and full of original observations on the many interesting features of the region visited. Dr. P. Jonas, contributes the conclusion of a paper begun some time since on Venezuela, describing a journey he made through the Llanos to the Apure. Dr. Emin Bey continues his valuable narrative of his journey from Mruli to the chief town of Unyoro, and Herr B. Hassenstein describes the north coast of Siberia between the mouth of the Lena and Behring Strait.

NEWS, dated February 23, have just been received at Vienna from the Hungarian Expedition travelling in China under the leadership of Count Bela Szechenyi. Count Szechenyi, Lieutenant Kreitner, and Herr L. Loczi, started from Sia-an-Sen, and after a very laborious march of 20 days, during which they had to pass several mountain chains measuring more than 3,000 metres in height, finally arriving at Lan-Chan-Sen. The province of Shen-Si, where, as in Shan-si and Konan a famine was raging, showed decay and ruin everywhere; the same state of things prevailed in the province of Kiang-Su. The long rebellion of the last years has left these unenviable traces. The expedition intended to leave for Su-tshou on February 14, on which march they would have to pass the Hoang-ho river.

AT the last meeting of the Berlin Geographical Society the President, Dr. Nachtigal, communicated the latest reports received from the German African travellers. Engineer Schütt has started on his journey into the interior and believes that he has now succeeded in overcoming all the difficulties which at first presented themselves to his further progress towards the East and North; he now intends entering the country of the Adjellengo tribe. Dr. Buchner was detained at Cassenge through the rainy season. He intended leaving for the interior at the beginning of May. Dr. Gerhard Rohlfs has had much to endure from the fanaticism of the natives at Djalo, where he is still staying, and has also been unable to obtain a guide through the Wadai desert on account of the unfriendliness of the Bengasine Government. His companion Dr. Strecker has returned to Bengasi in the meantime in order to attempt to make the Government more favourably disposed towards Dr. Rohlf's undertaking.

ON June 3rd the Dutch North Polar Expedition sailed from Amsterdam on board the "Willem Barends." The ship is equipped with all necessaries for 10 months.

A CARAVAN from Abyssinia has arrived at Marseilles, being destined for the acclimatization garden of Paris. It is composed of 15 men, 4 women, 2 children, 32 camels, 4 oxen, 2 zebras, 4 elephants, 8 ostriches, asses, and horses from Dongola and Abyssinia.

THE Batavian Society of Arts and Science have published in English in a recent volume of their Transactions some curious notes on the Malay Archipelago and Malacca, which have been compiled from Chinese sources by Mr. W. P. Groeneveldt.

NOTES

WE regret to say that although all critical symptoms have disappeared, Sir Wyville Thomson is not regaining strength so fast as was at first hoped. It will be some time still before he can attend to business letters. In the meantime all communications connected with *Challenger* matters should be addressed either to Mr. John Murray, his Principal Assistant, *Challenger* Office, 31, Queen Street, Edinburgh, or his Secretary, Mr. George Leslie, University, Edinburgh.

PROF. A. R. RAMSAY has been elected a Foreign Corresponding Member of the R. Accademia dei Lincei. At the same time Drs. vom Rath and Donders were elected to a similar honour.

PROF. AUGUST KROENIG, the author of "Grundzüge einer Theorie der Gase," died at Berlin on June 5, after a year's illness.

IN the death of Prof. Carl Theodor Ludwig Neubauer, to which we briefly alluded in our last number, German chemistry has lost one of its most accomplished specialists. Neubauer was born at Lüchow in 1830. After a fair high-school education and some experience as an apothecary he entered, at the age of twenty-three, the laboratory of the famous analytical chemist, Fresenius, at Wiesbaden, in the capacity of assistant. In 1856 he commenced his pedagogical career as privat-docent, and received in 1864 a professor's chair. At an early period he became a recognised authority in various branches of analytical, agricultural, and physiological chemistry, and especially in the chemistry of the urine, to which he has always devoted his chief attention. His researches in this department embrace the detection of various normal and abnormal constituents previously unknown, and the elaboration of exact methods for the qualitative and quantitative analysis of urine. The manual of Neubauer and Vogel on this subject, which reached its seventh edition in 1876, is regarded as the most exhaustive and complete work of the kind. The various higher derivatives of the urea group occurring in nature, such as xanthin and kreatin, were also made the base of careful research. Neubauer's investigations into the chemistry of wine have likewise

been productive of valuable results, and his work on this subject, which appeared in 1870, has been successively rendered into English and Italian. No small portion of his time was devoted to the perfection or invention of new general analytical methods, and in this connection mention should be made of his careful, critical reviews of the progress of analytical chemistry, which have formed so important a part of Fresenius' *Zeitschrift für analytische Chemie* since its foundation in 1862. Neubauer was honoured successively by calls to professorships in Zurich, Tübingen, and Erlangen, all of which he declined; preferring the more quiet, if somewhat limited field offered to his activity in Wiesbaden.

THE Council of the Society of Arts have awarded the following medals for papers read during the past session of the Society:—To Mr. Alfred Haviland, M.R.C.S., for his paper on the distribution of disease popularly considered; to Mr. John Holloway for his paper on a new application of a process of rapid oxidation, by which sulphides are utilised as fuel; Mr. Conrad W. Cooke for his paper on Edison's new telephone; Mr. Thomas Wardle for his paper on the wild silks of India, especially Tussah; and Dr. Wm. Wallace, F.R.S.E., for his paper on gas illumination.

MR. JOHN FISKE, whose able work on "Cosmic Philosophy" is familiar to our readers, is just now in England, and has put in the hands of Messrs. Macmillan and Co., for early publication, a volume of essays on Darwinism and other subjects of a kindred nature.

As our readers know, there are one or two vacant seats in Parliament for which there is already busy competition throughout the country. Sir John Lubbock, in a letter to the *Times*, suggests that one of them be devoted to science. "As the time is approaching," he writes, "when the distribution of the vacant seats will claim the attention of Her Majesty's Government, I would suggest whether one of them might not with advantage be allotted to the Royal Society. The members of that Society are all men eminent in their respective branches; they would form a constituency second to none in the United Kingdom, and would certainly send a representative who would be a valuable addition to the House of Commons. The agricultural, manufacturing, and commercial interests, the military and naval services, and the law are all strong in the House of Commons; literature is represented by the University members; but science, the practical importance of which is daily increasing, has no voice in the deliberation of the nation. The proposal which I venture to suggest would likewise have the merit of introducing some additional variety into our representative system. The alternative would be that there should be one more member for a great borough or a populous county. Lastly, I may add that the constituency, though not large, would be by no means among the smallest in the United Kingdom."

WE are requested to explain that the paragraph in the Astronomer-Royal's report relating to the performance of the Westminster clock, referred to its going during the exceptionally severe weather of the past winter. On the average of the whole twelve months it would appear that the present is the best year but one of the clock's performance, *it having been within one second of true time on* 80 *per cent.* of the days of observation.

ONE of the most interesting novelties in the Berlin Exhibition is the construction of an electrical railway by Siemens and Halske. The electrical power is supplied by a dynamo-electric machine worked by a steam-engine to another dynamo-electric machine, which works the wheels of an electric locomotive. The length of the way is 200 metres, the velocity three metres per second; the number of waggons three, and passengers twenty. The same experiment will be tried at the Scientific Exhibition at the Paris Palais de l'Industrie, with Marcel Deprez's motor, which is very promising. A new model has been constructed, weighing seven kilograms, and with twelve Bunsen elements can give a man-power. This model of Marcel Deprez's is exhibiting now at Lille, on the occasion of one of the ascents of the Aëronautical Academy. It is hoped that it will have force enough to work an aërial helix for ascending and descending without any sacrifice of ballast and escape of gas.

AN interesting ceremony has just taken place at Paris. The pupils of the École Centrale, which was founded at Paris in 1829 by MM. Dumas, Lavallè, Perdonnet, and a number of engineers for promoting education in practical science, has celebrated the fiftieth anniversary of that event. The new institution was so prosperous that a few years ago it was purchased by the Government and made a public institution. It would be difficult to give an idea of the number and importance of the positions occupied by the pupils of the École Centrale in French industry. It may be said without any exaggeration that they have been employed in the construction of almost every railway in France and perhaps on the Continent. Most of the French jurymen to the several international exhibitions have been educated there. M. Dumas, who enjoys excellent health, and may expect as long a career as his friend, M. Chevreul, is the only founder alive, and consequently was the hero of the celebration. On June 20 he was received at the Hotel of the Rue Couture St. Gervais, where the school is situated, by the members of the Conseil de Perfectionnement, directors and pupils, who offered him a testimonial of gratitude. On June 21 a great meeting was held at the Trocadero, in the large hall, under the presidency of M. Tirard, Minister of Agriculture and Commerce, M. Dumas sat at his right. M. Dumas, who is an eloquent and powerful speaker, delivered a most impressive address. He spoke on the obstacles which the founders met with, and after having explained how they had managed to win success, he exclaimed, "We had faith, and you proved that we were right in having it." At seven o'clock the pupils met at the Continental Hotel, having invited MM. Dumas, de Lesseps, Boisson, vice-president of the Chamber of Deputies, and a number of leading railway engineers, and others.

THE memory of the great Swedish botanist Linné (Linnæus) is about to be honoured in a fitting manner by his countrymen. In the State Budget for 1880 a sum of 80,000 Swedish crowns is set aside for the purchase of the Hammarby estate, near Upsala, which originally belonged to Linné, as well as of a quantity of furniture he once possessed. This new Linné Museum will be placed under the superintendence of the Rector of Upsala University.

AT the last meeting of the Geological Society, Prof. Prestwich announced that the next International Geological Congress will be held at Bologna in September, 1881, and that the President of the Committee, Prof. Capellini, had written, requesting co-operation on the part of the Geological Society and its Fellows. Among the matters which would be brought forward at this Congress would be the unification of geological nomenclature and the symbols used in geological mapping.

A ZOOLOGICAL station similar to that at Naples is about to be established at Messina.

WHAT with its museums and learned societies, the Berlin *Times* correspondent writes, Berlin is fast becoming a highly-favourable centre for the study of ethnology. Some time ago a tribe of Esquimaux attracted large crowds to their quarters in the Zoological Gardens. A family of Patagonians is waiting impatiently to be introduced by Prof. Virchow to the Anthropological Society to-morrow evening, while the latest phase of

enterprise in this respect is nothing more nor less than the importation of half-a-dozen live Zulu Caffres!

Dr. Elliott Coues's Bibliographical Appendix to his "Birds of the Colorado Valley" has proved, the New York *Nation* states, the occasion of one of the highest compliments paid of recent years to American science. A memorial has been addressed to him, signed by Prof. Flower, Huxley, Darwin, Mivart, Wallace, Gould, Sclater, Günther, Newton, and numerous other eminent English zoologists, declaring his special fitness to undertake a complete Bibliography of Ornithology, and urging the importance—the indispensableness, in fact—of his visiting the older European libraries in order, for the non-American portion, to consult every work mentioned at first hand. They express the hope that the same official liberality which has permitted Dr. Coues to remain in Washington for the prosecution of his bibliographical labours, will grant him leave of absence and provide the means for carrying out the wishes of the memorialists; and they promise him a warm welcome to England and every assistance in their power. Such a call, the *Nation* thinks, ought to be irresistible, and has every reason to believe that it will be heeded.

The fine collections, consisting mainly of insects, of Dr. A. Boucard, the results of many years' gathering from all parts of the world, are for sale.

Prof. Dubois-Reymond showed in 1859 that the polarisation of amalgamated zinc electrodes in aqueous solution of zinc sulphate was, with use of very weak polarising currents, extremely small, and he called such a combination "unpolarisable." This mere approximation seems to have been since misapprehended, and it has been quite overlooked that the non-polarisability is quite lost with increasing strength of current. In experiments lately made by Herr H. F. Weber, in order to test the laws of hydro-diffusion (*Vierteljahrsschrift der naturf. Ges. zu Zurich*, vol. xxiii.), it has appeared that between amalgamated zinc plates in zinc sulphate solution, a very definite polarisation occurs, and may even be employed as a method of measurement for the progress of the diffusion. This polarisation, however, is not the consequence of electrolytic processes at the electrodes, but of changes of concentration in the layers of zinc sulphate solution in contact with the electrodes, produced by passage of the ions. A sample experiment with amalgamated zinc plates, not placed vertically opposite each other, but horizontally, one over the other, proves the correctness of this assertion.

The Scinde *Civil and Military Gazette* describes a remarkable hailstorm that burst over Hala on May 8. The storm, we believe, was purely local. It commenced about four o'clock in the afternoon, coming up from the north-west with a strong wind and preceded by a heavy dust-storm. On the first burst the hailstones were, in form, flattened cones, with a central belt of snow-like ice and outer belts of clear ice. After the first fall of hail and rain the storm swept on to the south. There was a short lull, when the storm, working apparently in a circle, again broke over Hala, this time coming up with the wind from the south. Thunder and lightning were now continuous, the thunder, in fact, never ceasing for an instant, and a fall of enormous hailstones took place. These, unlike those of the first fall, were spherical in shape, snow-like in appearance, and in size larger than the largest marble—one, whose diameter was estimated, being an inch and a half across—as large, that is, as an ordinary hen's egg. For some time after the storm the ground was thick and white with the monstrous hailstones; except under trees, where beds of leaves and branches lay, broken and beaten off from above. The storm continued from first to last for about one hour and a half, and went off towards the north-east.

The *Henry Giffard* captive balloon has been inspected by the public authorities of Paris, and opened to the public for ascents.

In a recent medical report from Chinkiang, on the Yangtsze-kiang, in the neighbourhood of which there are immense depôts of salt, Dr. A. R. Platt mentions that he has observed a form of skin disease, presenting all the essential symptoms of ecthyma, yet with others that do not properly belong to that affection, and all so aggravated as to make the variety unique in his experience. It appears to be peculiar to workers in salt, judging from the four cases Dr. Platt has seen, all of whom were females, and all engaged in salt smuggling. They did not hesitate to attribute their condition to their daily habit of carrying large quantities of salt in girdles next the skin, so as to be concealed by their clothing, though, as the eruption first appeared on the hands, they were more inclined to lay it down to the preparation of the packages than to the transportation, and informed Dr. Platt that it was quite common among the people at the salt stations whence they procured their illicit supplies. Dr. Platt in his report furnishes a detailed account of the symptoms exhibited in the cases referred to, and of the line of treatment which he adopted with very satisfactory results.

The Municipal Council of Paris has adopted a proposal made by M. de Villiers, Chief Engineer of Ponts-et-Chaussées, for establishing at the Trocadero a stone which will be the zero point of levelling for Paris and the Seine Department. It is stated that the Minister of Public Works will order such a stone to be erected in the chief city of each department. All these stones will be related to each other by the Bourdaloue levelling which was made many years ago, and which takes for zero the mean level of the Mediterranean at Marseilles; this last is supposed, of course, as invariable.

The French Minister of Agriculture has published a report on the agricultural educational institutions of France, which shows an immense variety. The head establishment is the École Supérieure of Agriculture at the Conservatoire des Arts et Métiers. Next to this institution are the regional schools of agriculture as at Grignon and several other places. A number of special subjects have schools devoted to them, as the veterinary school at Alfort, schools of gardening at Versailles, schools of draining and irrigation in Brittany; a school of pisciculture has been established at Huningue, which was lost to France with Alsace; there are also schools for sheep-rearing, vine-growing, &c. The Vincennes farm and some others are devoted to experimental agriculture. Farmers' schools are located in several parts of the country, and kept by private individuals at their own expense, with a subsidy from townships or departments for training young men in several agricultural specialties. We may also consider as a part of these institutions the School of Arboriculture in the Luxembourg, and the School of Insectology in the same garden; although they have no registered pupils, they have lecturers and museum and experimental grounds at their disposition.

A translation of Fau's "Anatomie Artistique," by Dr. Carter Blake, of Westminster Hospital, will shortly be published by Messrs. Baillière, Tindall, and Cox.

A Russian paper gives an account of a plague of locusts near Elisabetpol, which forced a detachment of troops on the march to retrace their steps. They settled so thick on the soldiers' faces, uniforms, and muskets, that the major, driven to desperation, ordered firing at them for half an hour, but this produced no effect, and a march back was ordered. The swarm covered an area of thirty-five square versts.

A swarm of butterflies passed over Worms on the 13th and 14th, proceeding from north-west to south-east.

A JAPAN paper mentions a curious instance of Japanese thrift at Osaka. The paper made at the mill there is mostly manufactured from blue rags, and the water in which they are boiled has hitherto only poisoned the watercourses; henceforth it is to be saved and the indigo extracted from it.

THE Manchester people have entered a fresh protest against centralisation by the publication of the *Manchester Magazine*, No. 2 of which lies before us, and devotes a fair proportion of its space to articles in science. Mr. L. H. Grindon writes on the art of distinguishing trees, and Mr. Angell on the Manchester Science Lectures. Prof. Osborne Reynolds writes on the Manchester Philosophical Society, and there are articles on Stargazing, the Phonograph, the Weather, &c. Indeed the bulk of the magazine is scientific.

THE University Library at Strassburg has, according to the latest news, now reached the total of 470,000 volumes.

WE have received a very favourable Report of the Auckland (N.Z.) Institute for 1878-9. A considerable number of papers bearing on the natural history of New Zealand have been read during the session.

THE additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus*) from India, presented respectively by Mr. G. T. Close and Miss E. Cattlin; a Garnett's Galago (*Galago garnetti*) from East Africa, presented by Mr. F. W. Barff; two African Civet Cats (*Viverra civetta*) from Africa, a Kinkajou (*Cercoleptes caudivolvulus*) from Demerara, presented by Lieut. M. B. Salmon, Indian Staff Corps; two Egyptian Gazelles (*Gazella dorcas*) from Egypt, presented by Commander J. Pratt, s.s. *Java*; a Persian Gazelle (*Gazella subgutturosa*) from Persia, presented by Mr. C. H. Watts; three Hyacinthe Porphyrios (*Porphyrio hyacinthinus*) from West Africa, two Egyptian Kites (*Milvus ægyptius*) from Egypt, presented by Mr. A. Bells; a greater Sulphur-Crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. J. W. Taylor; a Slender-billed Cockatoo (*Licmetis tenuirostris*) from South Australia, presented by Mr. Geo. Wood; a Ring-necked Parrakeet (*Palæornis torquatus*) from India, presented by Mr. E. F. Carey; four Australian Wild Ducks (*Anas superciliosa*) from Australia, presented by Messrs. A. H. Jamrach and Charles Rice; two Pied Wagtails (*Motacilla yarrelli*), British Isles, presented by Mr. A. F. Wierner; a Common Badger (*Meles taxus*), British Isles; a Ceram Lory (*Lorius garrulus*) from Moluccas, an American Robin (*Turdus migratorius*) from North America, a West African Python (*Python sebæ*) from West Africa, a Reticulated Python (*Python reticulatus*) from Molucca, eleven Spotted Salamanders (*Salamandra maculosa*), European, deposited; a Beech Marten (*Martes foina*) from Russia, a Brazilian Tanager (*Ramphocœlus brasilius*) from Brazil, twenty Spotted Salamanders (*Salamandra maculosa*), European, purchased; a Collared Fruit Bat (*Cynonycteris collaris*), two Jameson's Gulls (*Larus jamesoni*), bred in the Gardens.

THE NATURAL HISTORY MUSEUM

THE following memorial has been recently presented to the Earl of Beaconsfield:—

To the Right Hon. the First Lord of the Treasury

My Lord,—In accordance with a resolution adopted by the General Committee of the British Association for the Advancement of Science at their last meeting, the Council of the Association beg leave to call your attention to the following circumstances.

1. In their fourth Report, presented to Parliament in 1874, the Royal Commission on Scientific Instruction and the Advancement of Science, having fully considered the present state of the Natural History Departments in the British Museum, and taken evidence thereon from the principal scientific authorities of the country, state that they have come to the conclusion "that the objections to the present system of government of the British Museum by a Board of Trustees as at present constituted, so far as relates to the Natural History Collections, are well founded, and that they have been unable to discover that the system is attended by any compensating advantages." They, therefore, recommend:— "(1) That the occasion of the removal of these collections to the new buildings now being erected at South Kensington for their reception, be taken advantage of to effect a change in the governing authority and official administration of that division of the Museum. (2) That a director of the National Collections should be appointed by the Crown, and should have the entire administration of the establishment, under the control of a Minister of State, to whom he should be immediately responsible, and that the keepers of collections should be responsible to the director. That the appointments of keepers and other scientific officers should be made by the Minister, after communication with the Director and with the Board of Visitors (hereinafter referred to). And that the Director should prepare the estimates, to be submitted, after consultation with the Board of Visitors, for the approval of the Minister. (3) That the present superintendent be the first director. (4) That a Board of Visitors be constituted. That the Board be nominated in part by the Crown, in part by the Royal and certain other scientific Societies of the metropolis, and, in the first instance, in part also by the Board of Trustees; the members to be appointed for a limited period, but to be re-eligible; and that the Board of Visitors should make annual reports to the Minister, to be laid before Parliament, on the condition, management, and requirements of the Museum, and should be empowered to give him advice on any points affecting its administration."

2. Exactly the same view as to the desirability of effecting a change in the government of the Natural History Collections was taken in a memorial presented to the then Chancellor of the Exchequer in 1866, and signed by the Presidents and other well-known members of the Royal, Linnean, and Zoological Societies, a copy of which is appended hereto.

3. Notwithstanding these expressions of opinion, in which nearly all the leading naturalists of the day fully concur, an Act was passed at the close of the last session of Parliament by which the Trustees of the British Museum have been authorised to transfer the Natural History Collections into the new building at South Kensington, without making any change whatever in the present mode of their administration.

4. The Council of the British Association feel that it is not necessary for them to press upon the Government the arguments for the changes in the administration of the Natural History Collections which have been so amply stated by the Commissioners in the Report above-mentioned. The Council think it sufficient to call the attention of the Government to the fact that the provisions of the act are directly at variance with the recommendations of the Royal Commissioners.

5. As, however, a fresh application to Parliament will be necessary in order to defray the expense of the removal of the Natural History Collections from their present situation to South Kensington, the Council of the British Association beg leave to point out to H.M. Government that the question of the administration of the Natural History Collections is one of the utmost importance as regards the future progress of Natural History in this country, and to urge upon them to take the opportunity which will thus present itself of effecting the alterations in the mode of administration of the Collections recommended by the Royal Commission. We have the honour to be, your Lordship's most obedient servants,

The Council of the British Association
for the Advancement of Science

Signed, for the Council, W. SPOTTISWOODE, *President*
DOUGLAS GALTON, P. L. SCLATER, } *Secretaries*

COPY OF A MEMORIAL PRESENTED TO THE RIGHT HON. THE CHANCELLOR OF THE EXCHEQUER

To the Right Hon. the Chancellor of the Exchequer

London, May 14, 1866

SIR,—It having been stated that the scientific men of the Metropolis are, as a body, entirely opposed to the removal of the Natural History Collections from their present situation in the British Museum, we, the undersigned Fellows of the Royal, Linnean, Geological, and Zoological Societies of London, beg leave to offer to you the following expression of our opinion upon the subject:—

We are of opinion that it is of fundamental importance to the progress of the natural sciences in this country that the administration of the National Natural History Collections should be separated from that of the Library and Art Collections, and *placed under one officer, who should be immediately responsible to one of the Queen's Ministers,*

We regard the exact locality of the National Museum of Natural History as a question of comparatively minor importance, provided that it be conveniently accessible and within the Metropolitan District.

GEORGE BENTHAM, F.R.S., F.L.S., F.Z.S.
WILLIAM B. CARPENTER, M.D., F.R.S., F.L.S., F.G.S.
W. S. DALLAS, F.L.S.
CHARLES DARWIN, F.R.S., F.L.S., F.Z.S.
F. DUCANE GODMAN, F.L.S., F.Z.S.
J. H. GURNEY, F.Z.S.
EDWARD HAMILTON, M.D., F.L.S., F.Z.S.
JOSEPH D. HOOKER, M.D., F.R.S., F.L.S., F.G.S.
THOMAS H. HUXLEY, F.R.S., V.P.Z.S., F.L.S., F.G.S.
JOHN KIRK, F.L.S., C.M.Z.S.
LILFORD, F.L.S., F.Z.S.
ALFRED NEWTON, M.A., F.L.S., F.Z.S.
W. KITCHEN PARKER, F.R.S., F.Z.S.
ANDREW RAMSAY, F.R.S., V.P.G.S.
ARTHUR RUSSELL, M.P., F.R.G.S., F.Z.S.
OSBERT SALVIN, M.A., F.L.S., F.Z.S.
P. L. SCLATER, F.R.S., F.L.S., F.Z.S.
G. SCLATER-BOOTH, M.P., F.Z.S.
S. JAMES A. SALTER, M.B., F.R.S., F.L.S., F.Z.S.
W. H. SIMPSON, M.A., F.Z.S.
J. EMERSON TENNENT, F.R.S., F.Z.S.
THOMAS THOMSON, M.D., F.R.S., F.L.S.
H. B. TRISTRAM, M.A., F.L.S.
WALDEN, F.Z.S., F.L.S.
ALFRED R. WALLACE, F.R.G.S., F.Z.S.

SCIENTIFIC SERIALS

THE *Archives des Sciences physiques et naturelles* (May, 1879) contain the following more important papers:—Geological review of Switzerland for the year 1878, by M. Ernest Favre (continuation).—On the lake-dwellings of the Swiss lakes, by Dr. F. A. Forel.—On the rotatory power of isocholesterine, by E. Schulze.—On the existence in a gaseous state of nitrous anhydride and nitrous acid, by G. Lunge.

The Rivista Scientifico-Industriale (No. 10, 1879) contains the following articles:—On a new instrument to study microseismic phenomena, by Prof. Giovanni Mugna.—On the regress canals for the filling of ponds, by Francesco Cagnacci (3 plates).—On the present state of Mount Vesuvius, by Prof. Semmola.—On the blue colours in manufacture of porcelain, by V. Joclet.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, June 5.—Prof. Allman, F.R.S., president, in the chair.—Attention was called to an article on Cinchona in India, by Mr. J. E. Howard. *Calisaya Ledgeriana* is shown to yield excellent results, as much as 10 per cent. of quinine, and of excellent quality, being obtained.—Prof. Parker read a memoir on the structure and development of the skull in the Urodelous amphibia. Several forms are here worked out, the Spotted Salamander serving as a type. Some of the so-called skin bones appear early, other investing bones appear later, and the investing cartilaginous roof of the nose comes after the ear capsule cartilages. Some Urodela show a stapes absent in Ceratodus and Lepidosiren. The transformations of the Anoura are carried on in the plastic larva and young to a greater extent than in the Urodela.—A paper on the Lichens collected during the English Polar Expedition of 1875–76, by Prof. Fries, of Upsala, was communicated by Sir J. D. Hooker. In Dr. Hayes's Arctic journey lichens probably were not brought away from a more northerly position than 78° N. lat., but Julius Payer, in the German Expedition, with certainty obtained specimens at Cape Fligely, 82° 5′ N. lat. With the exception of these last, but three species of lichens hitherto have been published as found beyond 81° N. lat. Thus considerable interest is attached to those got under Capt. Sir G. Nares by Capt. Feilden, of the *Alert* and Mr. Hart of the *Discovery*. As these vessels wintered in different quarters, the localities where the lichens were obtained correspondingly are more numerous, thus adding to their value as indicative of vegetable life in the frozen regions. Mr. Hart, got his at thirteen stations, Discovery Harbour, 81° 42′ N. lat., being the most northern; Capt. Feilden records twelve stations, Westward Ho Valley, 82° 41′ N. lat. being the limit. But Lieut. Aldrich gathered *Gyrophora cylindrica* on the shore of the "Palæocrystic Sea," the northernmost spot trodden by man, viz., Cape Columbia, 83° 6′ 30″ N. lat. Prof. Fries notes that the so-called "fruticolous" and "foliaceous" lichen species are feebly represented, doubtless accounted for by the severe climate, but seemingly at variance with the presence of musk oxen; added to which the reindeer moss is absent. This anomalous circumstance of the presence of large ruminants and deficiency of their usual lichen food, Capt. Feilden explains by stating that the musk ox in Grinnel Land does not feed on lichens, but on mosses and grasses. The same officer has also pointed out that the lichen growth curiously enough increased in size of species with increase of altitude. Prof. Fries concludes that, without the least credit being given to an open Polar sea (existing, no doubt, only in fancy), lichen vegetation may exist at the very Pole, if only land be there, and occasionally free from snow or ice. Among the series obtained in the Expedition, save a very few, all the forms of lichens of over 100 are already known. The abstract of a fourth contribution to the Mollusca of the *Challenger* Expedition, by the Rev. R. Boog Watson was read. This dealt with the Trochidæ and Turbinidæ.—The Secretary also read a communication on a remarkable new form of Helvella, this fungus being described by Mr. W. Phillips.—Mr. C. B. Clarke summarised a lengthened memoir by him, viz., a "A Review of the Ferns of North India." He showed that many of the localities given by Dr. Wallich, and doubtfully received by botanists were doubtless correct.—Mr. A. D. Michael was elected a Fellow of the Society.

Zoological Society, June 17.—Prof. W. H. Flower, F.R.S., president, in the chair.—Mr. Sclater exhibited a skin of *Ara glauca*, from Mr. Boucard's collection, obtained at Corrientes, and stated that having compared it with the *Ara* now in the Gardens, purchased in June, 1860, and hitherto named *A. glauca*, he had come to the conclusion that the living bird belonged to the allied form *Ara leari*.—Prof. Flower called attention to the skull of the female sea-lion, which had lately died at the Southport Aquarium, and pointed out that it belonged to *Otaria gillespii*, and not, as had been supposed, to *Otaria stelleri*.—Mr. C. G. Danford exhibited and made remarks on some remarkable antlers of deer, which he had obtained during his recent journey in Asia Minor.—Prof. Newton exhibited skins of some rare species of birds obtained by Mr. Edward Newton, C.M.Z.S., in Jamaica.—Mr. F. D. Godman exhibited and made remarks on a drawing of the manatee by Mr. Wolf, taken from the specimen lately living in the Westminster Aquarium.—Hans, Graf von Berlepsch, exhibited and made remarks on the skins of two varieties of the long-tailed titmouse (*Mecistura caudata*), which occurred near Cassel, in Germany, one of which appeared to be the same as the British form of this bird.—Dr. J. Murie read a paper on the manatee, containing the results of his examination of the specimen which was lately living in the Westminster Aquarium. The peculiar attitudes assumed by the animal in life, the great mobility of the upper lip, and the occasional use of the limbs in feeding were noted. As regards the anatomy, the chief points dwelt on were the shape of the brain and its suppressed convolutions. The vexed question of the number of the cervical nerves and their distribution was also discussed.—A communication was read from Mr. A. H. Garrod, on the brain and on other points in the structure of the adult male hippopotamus, which was presented to the Society by the late Viceroy of Egypt, in 1850, and which died in the Society's gardens in March, 1878.—A second communication from Mr. Garrod contained a note on the mechanism of respiration, as well as of the retraction of the head and limbs in certain chelonia.—Dr. Gwyn Jeffreys communicated the second part of his work on the mollusca of the *Lightning* and *Porcupine* Expeditions, embracing the families from *Anomiidæ* to *Arcidæ*. The number of species noticed was 100, of which 4 were new to science, and 15 were hitherto unfigured. Particulars were given of the geographical and geological distribution of all the species, and their synonymy was discussed. Some species of *Leda* and *Malletia* were Sicilian fossils of the pliocene formation, and had not been previously known as recent or living. These species

occurred at great depths, a fact which showed that the sea-bed in that part of the Mediterranean had been considerably raised since the tertiary epoch.—Mr. Edward R. Alston read a note on the *Acanthomys leucopus* of Gray, showing that it does not belong to the genus *Acanthomys* but to *Mus* proper. As the name *leucopus* is pre-occupied in the latter genus, he proposed to call the species *Mus terræ reginæ*.—Mr. W. L. Distant read a paper on the African species of Lepidoptera of the genus *Papilio*. A new species from Magilia, East Africa, was described, and the name of *Papilio hornimani* was proposed for it. —A communication was read from the Count T. Salvadori, C.M.Z.S., containing further particulars of the new Pheasant from Western Sumatra which he had recently described as *Acomus inornatus*.—Messrs. Godman and Salvin gave an account of some hitherto unrecorded diurnal lepidoptera, obtained by the Rev. George Brown in Duke of York Island and New Ireland, together with descriptions of some apparently new species.—A communication was read from Mr. F. Jeffrey Bell, being the second of the series of his observations on the characters of *Echinoidea*. The present paper contained an account of the species of the genus *Tripneustes*.—Messrs. Sclater and Salvin read a paper on the birds of Bolivia, based principally upon an examination of the specimens obtained by Mr. Buckley during two expeditions into that country.

Geological Society, June 11.—Prof. Joseph Prestwich, F.R.S., vice-president, in the chair.—Noel W. Rudstone Read, was elected a Fellow; and M. Edouard Dupont, of Brussels, Dr. Franz von Kobell, of Munich, and Dr. Emile Sauvage, of Paris, Foreign Correspondents of the Society.—The following communications were read:—On a mammaliferous deposit at Barrington, near Cambridge, by Rev. O. Fisher, F.G.S. The gravel in which these remains were found is about 20 feet above the alluvial flat by the River Rhee, and is evidently post-glacial. The gravel contains some of the ordinary land and fresh-water shells, but not *Cyrena* or *Unio*. Remains of the following mammalia have been found:—*Ursus spelæus*, *Meles taxus*, *Hyæna spelæa*, *Felis spelæa*, *Cervus megaceros*, *elephus*, and another, *Bos primigenius*, *Bison priscus*, *Hippopotamus major*, *Rhinoceros leptorhinus*, *Elephas antiquus* and *primigenius*, with a worked flint, almost certainly from the same deposit. The author considers the abundance and admixture of these remains due to the locality having been a sort of eddy or pool in the old river. The remains are described, and the rest of the paper is occupied with a correlation of the gravel with others in the adjoining district, and a consideration of the physical conditions under which it was deposited.—Further discoveries in the Cresswell Caves, by Prof. Boyd Dawkins, F.R.S., and the Rev. J. M. Mello, F.G.S., with notes on the mammalia by the former. This paper contained the account of digging-operations carried on in one of the smaller caves of the Cresswell Crags, known as Mother Grundy's Parlour. The authors described the occurrence in the red clay and ferruginous sand of this cave of bones of hippopotamus and the leptorhine rhinoceros, proving the existence of these animals in the wooded valleys of the basin of the Upper Trent at the time of the accumulation of those deposits; while at the same time, so far as the evidence goes, there was an absence of palæolithic man, of the reindeer, and of horses, while hyænas were abundant. In a subsequent period, represented in all the caves by the red sand, the mammoth, woolly rhinoceros, horse, and reindeer inhabited the vicinity, and were subject to the attacks both of hyænas and of human hunters, whose quartzite implements prove them to belong to the same people whose traces are found in the river-deposits. In the breccia and upper cave-earth of the larger caves the existence of the palæolithic hunter is evidenced by flint implements, resembling those of Solutré, accompanied by implements of bone and antler. Associated with these was the incised figure of a horse described in a former paper. The authors finally dwelt briefly upon the characteristics of the caves in prehistoric and historic times, and indicated some of the anthropological points of interest connected therewith.—On the pre-Cambrian rocks of Shropshire, part 1, by C. Callaway, F.G.S.—On the occurrence of a remarkable, and apparently new mineral in the rocks of Inverness-shire, by William Jolly, F.R.S.E., H.M. Inspector of Schools, and J. Macdonald-Cameron, Fel. Inst. Chem., F.C.S. In this paper the authors refer to a blue mineral of a somewhat remarkable character, noticed at Englishton Moor and neighbourhood, distant westwards, from Inverness, about 5 miles, where the mineral occurs in scattered blocks. It has since been noticed at Moniack Burn, Reelig Glen, and South Clunes Farm, all in the same direction, but distant from Inverness about 10 miles; also near Dochfour House, at the north end of Loch Ness, close by Dochgarroch Lock of the Caledonian Canal. In colour and general appearance this mineral resembles crocidolite, but analyses point to its being more nearly related to ægirite, a member of the amphibole group, which has the general formula $Si3(\frac{1}{2}\ddot{\ddot{R}} + R^3)$. The mean of several analyses shows it to have the composition $6SiO_2$, Fe_2O_3, $2MgO$.

Physical Society, June 14.—Prof. W. G. Adams in the chair.—New Members: Donald Macalister, B.A., and Mr. St. George Lane Fox.—Prof. Macleod described a plan for suppressing the induction disturbances in a telephone circuit. It is known that a secondary battery composed of metal plates and sulphuric acid allows weak currents to pass while stopping those of high tension. Prof. Macleod inserted a secondary battery of platinum plate between the line and the telephone, but this stopped both the induction and the vocal currents. When platinum wires were substituted for the plates, however, the induction-currents were stopped, while the vocal currents could be feebly heard.—Dr. O. J. Lodge exhibited his new reversing key for electrometer work, which is preferred to the ordinary forms as giving a high insulation, small capacity, and not requiring the hand to approach close to it to work it. It consists of four platinum wires arranged in pairs crossing one another, one pair crossing between the other two. These are the terminals and contact pieces of the key. The middle pair are supported by an endless silk thread which runs on two pulleys, one of which is fitted with a handle. On turning the handle to right or left the two middle wires are brought into contact with one or other of the two outer wires, and the current reversed at will. The whole is inclosed in a metal box.—Mr. J. F. Moulton then demonstrated the results of the experiments of Mr. Spottiswoode and himself on the sensitiveness of electric discharges in vacuum tubes. These experiments were undertaken to find the cause of the luminous layers or strata in the discharge, a Holtz machine being employed. It was observed that when feeble currents were drawn from the machine, the discharge could be depressed by laying the finger on the tube, and this depression always occurs with intermittent currents, therefore the feeble currents form a continuous current Holtz discharge themselves, like intermittent currents, by reason of their feebleness. This sensitiveness of the discharge to the approach of the finger was found to be due to the conductivity and electric capacity of the hand. Electricity opposite in kind to the discharge is induced on the finger, and streaming upon the tube, neutralises part of the discharge therein. This effect was also shown by means of tinfoil rings round the tube. An intermittent current is of course capable of this static induction on neighbouring conductors. The luminous discharge in a vacuum-tube consists of a bright sharp glow at the negative terminal, followed by a dark space, then a hazy bluish light at the positive pole. The striæ or layers in these sensitive tubes merely repeat this appearance. They can be artificially produced by placing the fingers, or rings of metal, at intervals along a tube conveying an amorphous discharge; for in this case the induced electricity discharging itself from the fingers, breaks up the amorphous discharge into dark and bright layers. In these stratified discharges the electricity appears to travel *per saltum*, or by stepping-stones, as one may say, and the glow seems to be a molecular structure, a view which is supported by Mr. Crookes's experiments. A negative discharge from the finger produces a dark space in the tube discharge, and a positive one a bright line; therefore one can tell the kind of discharge passing in a tube by laying a finger on it. If the same pole be brought to both ends of a tube a discharge will still take place from each end, and there will be a dark space in the middle, the electricity here seeming to turn back again the way it came. The discharge from a pole through a vacuum tube would therefore appear to be not akin to conduction, but to a disruptive discharge. It is a leap in the dark, and the phenomena observed are due to the gaseous nature of the medium. These experiments point to the possibility of completing a circuit by positive electricity alone. Prof. Guthrie suggested that by combining vacuum-tubes with the conduction-balance of Prof. Hughes it might be possible to get an optical balance for measuring inductive capacity.—Dr. Henry Draper, of New York, who is now on a visit to England, then addressed the meeting on his alleged

discovery of oxygen in the sun by bright lines in the solar spectrum. He said that hitherto he had not been able to find these lines projecting from the limb of the sun, like hydrogen, and his impression is that oxygen resides lower than the reversing layer. He had lately been extending the dispersion of the spectrum of terrestrial oxygen, and from a light of maximum intensity of one-candle power had now got a dispersion of eighty inches from A to O. He exhibited two of the original negatives of the solar spectrum showing the bright lines. Mr. J. Norman Lockyer congratulated solar science on having so able a worker as Dr. Draper, and remarked that if Dr. Draper proved this case for even two or three O lines it would be sufficient, considering the variability of the spectrum of matter under different physical conditions. He also alluded to the traces of carbon which he himself had found in the sun by the dark flutings in the spectrum. Dr. Draper said he did not see why carbon should not give both bright and dark lines.—Mr. Scott exhibited a number of coloured photographs done after the method of M. Albert, of Munich.

Statistical Society, June 17.—Dr. William A. Guy, F.R.S., read a paper on tabular analysis. Dr. Guy began his paper by stating that its chief object was to call attention to a particular form of tabular analysis first proposed by Dr. Tweedy John Todd, of Brighton. Dr. Guy in the course of his paper mentioned briefly the inquiries to which he had applied Dr. Todd's method as modified by himself. He had made use of it in the inquiry entrusted to him in 1862 into the effects of the poison known as emerald-green when used in the arts; in comparing the statements made in the four gospels; in contrasting the evidence of different witnesses in the Tichborne case; in inquiries relating to poisoning by arsenic and strychnine; and in comparing poisoning by strychnine with tetanus. The general use of tabular forms for purposes of illustration was largely illustrated by various specimens which Dr. Guy had used in his lectures at King's College, and former papers read before the Society. They had reference to crime, to fluctuation in recurrent events, &c., &c. The author finished his paper by stating that he believed he did not attach undue importance to tabular analysis, or the discovery of truth by means of tabular forms, as distinct from tables of record and tables of illustration, when he anticipated from their intelligent and more extended use, not only greater accuracy of statement and completeness of description, but important discoveries also. The Statistical Society was dealing with a vast array of facts, into which scientific methods and scientific treatment are ever introducing more and more of order, more and more of light.

PARIS

Academy of Sciences, June 16.—M. Daubrée in the chair.—The following papers were read:—Transmission of the hour at Paris Observatory to commercial ports for regulation of chronometers, by M. Mouchez. He is hoping to accomplish this once a week, at least, by telegraph; but the expense is at present a difficulty.—On the development of the perturbative function where, the eccentricities being small, the mutual inclination of the orbits is considerable, by M. Tisserand.—On the spherical regulating spiral of chronometers, by M. Phillips.—Observations on M. Lamarsky's note on Stokes's law, by M. E. Becquerel. The phenomena of fluorescence do not depend on a simple change of refrangibility of luminous rays falling on a body (as M. Lamarsky seemed to say), but on a complete transformation of the vibratory movement. The illuminated body gives out, by an action proper to it, light whose composition cannot be connected in a simple way with the nature of the incident vibrations.—On the density of vapour of bisulphydrate of ammonia, by M. Sainte-Claire Deville. He gives details of this from old laboratory notes (having been reminded of the omission by MM. Engel and Moitessier).—Determination of the height of mercury in the barometer at the equator; amplitude of diurnal barometric oscillations at different stations in the Cordilleras (continued), by M. Boussingault. His observations at Bogota did not confirm Mutis's assertion of a lunar influence on the barometric heights, though a very delicate instrument was used. He found the average monthly heights greatest in June and July, least in December and January (when the earth is nearest the sun). He gives meteorological details regarding Antisana Farm, which is at an altitude of 4,100 metres.—On the last modifications made in the sluice of Aubois, and on the means used in it to deaden the percussions of the movable tubes on their seats, by preventing their rebound, by M. De Caligny.—M. Daubrée presented the first part of a work entitled "Synthetical Studies of Experimental Geology," being a collection of papers published during the last thirty years.—Observations of the planet 198, discovered at Marseilles Observatory, by M. Borrelly.—On the surface of the wave and the transformation of a pencil, by M. Mannheim.—On the employment of elliptic functions in the theory of the plane quadrilateral, by M. Darboux.—Theorems of indeterminate analysis, by M. Pepin.—Experiments on the resistance opposed by the air to movement of a surface, by M. Saint-Loup. A plate, inclined to the direction of motion, and fixed at the head of a horizontal radial bar, was driven round a vertical axis, a special arrangement being added to measure the resistance. The resistance for a plane surface of 1 square decimetre making angle ϕ with its path is expressed by the formula—

$$P_\phi = 0{\cdot}1768\,(4^{\sin\phi} - 1)\,V(11 + 1{\cdot}061\,V).$$

—On the electric dilatation of the armatures of Leyden jars, by M. Duter. He finds the law verified, which is expressed by the equation $u = \frac{KV^2}{e}$, where u is the increase of volume of the jar, e its thickness, V the difference of potential of its armatures, and K a coefficient characteristic of the apparatus. He considers that electric pressure is not the cause of the phenomenon, but that there is here a new phenomenon of electricity.—On the same subject, by M. Righi. He distinguishes *instantaneous* dilatation, due chiefly to polarisation of the glass, from *persistent* dilatation, not before observed, and due to development of heat; and he thinks it probable that at the same time the polarisation and perhaps also the attraction between the armatures produce in the glass a diminution of thickness.—On the suspension of clouds and their elevation in the atmosphere, by M. Oltramare. He offers a solution based on the idea that each molecule of a cloud is charged with electricity.—On the basic sulphydrates of ammonia, by M. Troost.—On a new natural sulphate of manganese (mallardite), and a new variety of sulphate of iron (luckite), by M. Carnot. These are from the gold and silver mines of Utah.—On the structure of cells of the kidney in the normal state, by M. Cornil. He finds them composed of two substances, the one peripheric and solidified by osmic acid, the other central, containing granulations and the nucleus of the cell.—Action of electric currents on the muscles of the claw of the crayfish, by M. Richet. Excited directly by strong induced currents, the muscle shows a very prolonged contraction, the duration of which is proportional to the intensity of the stimulus.—On the systematic position of Volvocineæ, and on the limits of the vegetable and animal kingdom, by M. Maupas. He agrees with Cohn and others in classing Volvocineæ among the algæ, with Palmellaceæ, &c.—Influence of media on the structure of roots, by M. Mez.—On a migration of butterflies of the species *Vanessa cardui*, observed at Angers on June 10 last, by M. Decharme.—On some modifications in the apparent colours of flowers by the electric light, by M. Hugo. Such changes were noticed in *Nedularium* and *Caladium*.

CONTENTS

THURSDAY, JULY 3, 1879

THOMSON AND TAIT'S NATURAL PHILOSOPHY

Treatise on Natural Philosophy. By Sir William Thomson, LL.D., D.C.L., F.R.S., Professor of Natural Philosophy in the University of Glasgow, Fellow of St. Peter's College, Cambridge, and Peter Guthrie Tait, M.A., Professor of Natural Philosophy in the University of Edinburgh, formerly Fellow of St. Peter's College, Cambridge. Vol. I. Part 1. New Edition. (Cambridge, at the University Press, 1879.)

THE year 1867 will long be remembered by natural philosophers as that of the publication of the first volume of "Thomson and Tait." They had long been waiting for the book, and in the preface the delay was accounted for by the necessity of anticipating the wants of the other three volumes, in which the remaining divisions of Natural Philosophy were to be treated. The reader was also reminded, that if in any passage he failed to appreciate the aim of the authors, the reason might be that what he was studying was in reality a prospective contrivance, the true aim of which would not become manifest until after the perusal of that part of the work for which it was designed to prepare the way.

What we have had before us now for twelve years was, the authors reminded us, strictly preliminary matter. The plan of the whole treatise could only be guessed at from the scale on which its foundations were constructed.

In these days, when so much of the science of our best men is dribbled out of them in the fragmentary and imperfectly elaborated form of the memoirs which they contribute to learned societies, and when the work of making books is relegated to professional bookmakers, who understand about as much of one subject as of another, it was something to find that even one man of known power had not shrunk from so great a work; it was more when it appeared that two men of mark were joined together in the undertaking; and when at last the plan of the work was described in the preface, and the scale on which its foundations were being laid was exhibited in the vast substructure of Preliminary Matter, the feeling with which we began to contemplate the mighty whole was one in which delight was almost overpowered by awe.

This feeling has been growing upon us during the twelve years we have been exploring the visible part of the work, marking its bulwarks and telling the rising generation what manner of a palace that must be, of which these are but the outworks and first line of defences, so that now, when we have before us the second edition of the first part of the first volume, we are impelled to risk the danger of criticising an unfinished work, and to say something about the plan of what is already before us.

The first thing which we observe in the arrangement of the work is the prominence given to kinematics, or the theory of pure motion, and the large space devoted under this heading to what has been hitherto considered part of pure geometry. The theory of the curvature of lines and surfaces, for example, has long been recognised as an important branch of geometry, but in treatises on motion it was regarded as lying as much outside of the subject as the four rules of arithmetic or the binomial theorem.

The guiding idea, however, which, though it has long exerted its influence on the best geometers, is now for the first time boldly and explicitly put forward, is that geometry itself is part of the science of motion, and that it treats, not of the relations between figures already existing in space, but of the process by which these figures are generated by the motion of a point or a line

We no longer, for example, consider the line AB simply as a white stroke on a black board, and call it indifferently AB or BA, but we conceive it as the trace of the motion of a point from A to B, and we distinguish A as the beginning and B as the end of this trace.

This method of regarding geometrical figures seems to imply that the idea of motion underlies the idea of form, and is in accordance with the psychological doctrine which asserts that at any given instant the attention is confined to a single and indivisible percept, but that as time flows on the attention passes along a continuous series of such percepts, so that the path of investigation along which the mind proceeds may be described as a continuous line without breadth. Our knowledge, therefore, of whatever kind, may be compared to that which a blind man acquires of the form of solid bodies by stroking them with the point of his stick, and then filling up in his imagination the unexplored parts of the surface according to his own notions about continuity and probability. The rapidity, however, with which we make our exploration is such that we come to think that by a single glance we can thoroughly see the whole of that surface of a body which is turned towards us, if, indeed, we are not prepared to assert that we have seen the other side too, when after all, if our attention were to leave a trace behind it, as the point of the blind man's stick might do, this trace would appear as a mere line meandering over the surface in various directions, but leaving between its convolutions unexplored areas, the sum of which is still equal to the whole surface. We are at liberty no doubt to course over the surface and to subdivide the meshes of the network of lines in which we envelope it, and to conclude that there cannot be a hole in it of more than a certain diameter, but no amount of investigation will warrant the conclusion, which, nevertheless we draw at once and without a scruple, that the surface is absolutely continuous and has no hole in it at all. Even when, in a dark night, a flash of lightning discloses instantaneously a whole landscape with trees and buildings, we discover these things not at at once, but by perusing at our leisure the picture which the sudden flash has photographed on our retina.

The reason why the phenomena of motion have been so long refused a place among the most universal and elementary subjects of instruction seems to be, that we have been relying too much on symbols and diagrams, to the neglect of the vital processes of sensation and thought.

It is no doubt much easier to represent in a diagram or a picture the instantaneous relations of things coexisting in space than to illustrate in a full and complete manner the simplest case of motion. When we have drawn our

diagram it remains on the paper, and the student may run his mind over the lines in any order which pleases him. But when we are either perceiving real motions, or thinking about them without the aid or the encumbrance of a diagram, the mind is carried along the actual course of the motion, in a manner far more easy and natural than when it is rushing indiscriminately hither and thither along the lines of a diagram.

Having pursued kinematics from its elementary principles till its intricacies begin to be appalling, we resume the study of the elements of science in the opening of the chapter on "Dynamical Laws and Principles." It is here that we first have to deal with something which claims the title of Matter, and our authors, one of whom never misses an opportunity of denouncing metaphysical reasoning, except when he has occasion to expound the peculiarities of the Unconditioned, make the following somewhat pusillanimous statement :—

"We cannot, of course, give a definition of *Matter* which will satisfy the metaphysician, but the naturalist may be content to know matter as *that which can be perceived by the senses, or as that which can be acted upon by, or can exert, force.*"

The authors proceed to throw out a hint about Force being a direct object of sense, and after telling us that the question *What is matter?* will be discussed in a future volume, in which also the Subjectivity of Force will be considered, they retire to watch the effect of the definition they have thrown into the camp of the naturalists.

Now all this seems to us very much out of place in a treatise on Dynamics. We have nothing of the kind in treatises on Geometry. We have no disquisitions as to whether it is by touch or by sight that we come to know in what way a triangle differs from a square. We have not even a caution that the diagrams of these figures in the book do not exactly correspond with their definitions. Even in kinematics, when our authors speak of the motion of points, lines, surfaces, and solids, though they introduce several modern phrases, the kind of motion they speak of is none other than that which Euclid recognises, when he treats of the generation of figures.

Why, then, should we have any change of method when we pass on from kinematics to abstract dynamics? Why should we find it more difficult to endow moving figures with mass than to endow stationary figures with motion? The bodies we deal with in abstract dynamics are just as completely known to us as the figures in Euclid. They have no properties whatever except those which we explicitly assign to them.

Again, at p. 222, the capacity of the student is called upon to accept the following statement :—

"Matter has an innate power of resisting external influences, so that every body, as far as it can, remains at rest or moves uniformly in a straight line."

Is it a fact that "matter" has any power, either innate or acquired, of resisting external influences? Does not every force which acts on a body always produce exactly that change in the motion of the body by which its value, as a force, is reckoned? Is a cup of tea to be accused of having an innate power of resisting the sweetening influence of sugar, because it persistently refuses to turn sweet unless the sugar is actually put into it?

But suppose we have got rid of this Manichæan doctrine of the innate depravity of matter, whereby it is disabled from yielding to the influence of a moving force unless that force actually spends itself upon it, what sort of facts are left us to be the subject-matter of abstract dynamics?

We are supposed to have mastered so much of kinematics as to be able to describe all possible motions of points, lines, and figures. In so far as real bodies have figures and motions, we may apply kinematics to them.

The new idea appropriate to dynamics is that the motions of bodies are not independent of each other, but that, under certain conditions, dynamical transactions take place between two bodies, whereby the motions of both bodies are affected.

Every body and every portion of a body in dynamics is credited with a certain quantitative value, called its mass. The first part of our study must therefore be the distribution of mass in bodies. In every dynamical system there is a certain point, the position of which is determined by the distribution of mass. This point was called by Boscovich the centre of mass—a better name, we think, than centre of inertia, though either of these is free from the error involved in the term centre of gravity.

In every dynamical transaction between two bodies there must be something which determines the relation between the alteration of the motions of the two bodies. In other words, there must be some function of the motions of the two bodies which remains constant during the transaction. According to the doctrine of abstract dynamics it is the motion of the centre of mass of the two bodies which is not altered on account of any dynamical transaction between the bodies. This doctrine, if true of real bodies, gives us the means of ascertaining the ratio of the mass of any body to that of the body adopted as the standard of mass, provided we can observe the changes in the motions of the two bodies arising from an encounter between them.

We then confine our attention to one of the bodies, and estimate the magnitude of the transaction between the bodies by its effect in changing the *momentum* of that body, momentum being merely a term for a quantity mathematically defined in terms of mass and motion. The rate at which this change of momentum takes place is the numerical measure of the force acting on the body, and, for all the purposes of abstract dynamics, it *is* the force acting on the body.

We have thus vindicated for figures with mass, and, therefore, for force and stress, impulse and momentum, work and energy, their places in abstract science beside form and motion.

The phenomena of real bodies are found to correspond so exactly with the necessary laws of dynamical systems, that we cannot help applying the language of dynamics to real bodies, and speaking of the masses in dynamics as if they were real bodies or portions of matter.

We must be careful, however, to remember that what we sometimes, even in abstract dynamics, call matter, is not that unknown substratum of real bodies, against which Berkeley directed his arguments, but something as perfectly intelligible as a straight line or a sphere.

Real bodies may or may not have such a substratum, just as they may or may not have sensations, or be capable

of happiness or misery, knowledge or ignorance, and the dynamical transactions between them may or may not be accompanied with the conscious effort which the word force suggests to us when we imagine one of the bodies to be our own, but so long as their motions are related to each other according to the conditions laid down in dynamics, we call them, in a perfectly intelligible sense, dynamical or material systems.

In this, the second edition, we notice a large amount of new matter, the importance of which is such that any opinion which we could form within the time at our disposal would be utterly inadequate. But there is one point of vital importance in which we observe a marked improvement, namely, in the treatment of the generalised equations of motion.

Whatever may be our opinion about the relation of mass, as defined in dynamics, to the matter which constitutes real bodies, the practical interest of the science arises from the fact that real bodies *do* behave in a manner strikingly analogous to that in which we have proved that the mass-systems of abstract dynamics *must* behave.

In cases like that of the planets, when the motions we have to account for can be actually observed, the equations of Maclaurin, which are simply a translation of Newton's laws into the Cartesian system of co-ordinates, are amply sufficient for our purpose. But when we have reason to believe that the phenomena which fall under our observation form but a very small part of what is really going on in the system, the question is not—what phenomena will result from the hypothesis that the system is of a certain specified kind? but—what is the most general specification of a material system consistent with the condition that the motions of those parts of the system which we can observe are what we find them to be?

It is to Lagrange, in the first place, that we owe the method which enables us to answer this question without asserting either more or less than all that can be legitimately deduced from the observed facts. But though this method has been in the hands of mathematicians since 1788, when the *Mécanique Analytique* was published, and though a few great mathematicians, such as Sir W. R. Hamilton, Jacobi, &c., have made important contributions to the general theory of dynamics, it is remarkable how slow natural philosophers at large have been to make use of these methods.

Now, however, we have only to open any memoir on a physical subject in order to see that these dynamical theorems have been dragged out of the sanctuary of profound mathematics in which they lay so long enshrined, and have been set to do all kinds of work, easy as well as difficult, throughout the whole range of physical science.

The credit of breaking up the monopoly of the great masters of the spell, and making all their charms familiar in our ears as household words, belongs in great measure to Thomson and Tait. The two northern wizards were the first who, without compunction or dread, uttered in their mother tongue the true and proper names of those dynamical concepts which the magicians of old were wont to invoke only by the aid of muttered symbols and inarticulate equations. And now the feeblest among us can repeat the words of power and take part in dynamical discussions which but a few years ago we should have left for our betters.

In the present edition we have for the first time an exposition of the general theory of a very potent form of incantation, called by our authors the Ignoration of Co-ordinates. We must remember that the co-ordinates of Thomson and Tait are not the mere scaffolding erected over space by Descartes, but the variables which determine the whole motion. We may picture them as so many independent driving-wheels of a machine which has as many degrees of freedom. In the cases to which the method of ignoration is applied there are certain variables of the system such that neither the kinetic nor the potential energy of the system depends on the values of these variables, though of course the kinetic energy depends on their momenta and velocities. The motion of the rest of the system cannot in any way depend on the particular values of these variables, and therefore the particular values of these variables cannot be ascertained by means of any observation of the motion of the rest of the system. We have therefore no right, from such observations, to assign to them any particular values, and the only scientific way of dealing with them is to ignore them.

But this is not all. Since these variables do not appear in the expression for the potential energy, there can be no force acting on them, and therefore their momenta are, each of them, constant, and their velocities are functions of the variables, but, since their own variables do not enter into the expressions, we may consider them as functions of the other variables, or, as they are here called, the retained co-ordinates, and of the constant momenta of the ignored co-ordinates.

From the velocities as thus expressed, together with the constant momenta, we obtain the contribution of the ignored co-ordinates to the kinetic energy of the system in terms of the retained co-ordinates and of the constant momenta of the ignored co-ordinates. This part of the kinetic energy, being independent of the velocities of the retained co-ordinates, is, as regards the retained co-ordinates, strictly *positional*,[1] and may be considered for all experimental purposes as if it were a term of the potential energy. The other part of the kinetic energy is a homogeneous quadratic function of the velocities of the retained co-ordinates. In the final equations of motion neither the ignored co-ordinates nor their velocities appear, but everything is expressed in terms of the retained co-ordinates and their velocities, the coefficients, however, being, in general, functions of the constant momenta of the ignored co-ordinates.

We may regard this investigation as a mathematical illustration of the scientific principle that in the study of any complex object, we must fix our attention on those elements of it which we are able to observe and to cause to vary, and ignore those which we can neither observe nor cause to vary.

In an ordinary belfry, each bell has one rope which comes down through a hole in the floor to the bellringers' room. But suppose that each rope, instead of acting on one bell, contributes to the motion of many pieces of machinery, and that the motion of each piece is deter-

[1] The division of forces into motional and positional is introduced at p. 370.

mined not by the motion of one rope alone, but by that of several, and suppose, further, that all this machinery is silent and utterly unknown to the men at the ropes, who can only see as far as the holes in the floor above them.

Supposing all this, what is the scientific duty of the men below. They have full command of the ropes, but of nothing else. They can give each rope any position and any velocity, and they can estimate its momentum by stopping all the ropes at once, and feeling what sort of tug each rope gives. If they take the trouble to ascertain how much work they have to do in order to drag the ropes down to a given set of positions, and to express this in terms of these positions, they have found the potential energy of the system in terms of the known co-ordinates. If they then find the tug on any one rope arising from a velocity equal to unity communicated to itself or to any other rope, they can express the kinetic energy in terms of the co-ordinates and velocities.

These data are sufficient to determine the motion of every one of the ropes when it and all the others are acted on by any given forces. This is all that the men at the ropes can ever know. If the machinery above has more degrees of freedom than there are ropes, the co-ordinates which express these degrees of freedom must be ignored. There is no help for it.

Of course, if there are co-ordinates for which there are no ropes, but which enter into the expression for the energy, then, if the motion of these co-ordinates is periodic, there will be "adynamic vibrations" communicated to the ropes, and by these the men below will know that there is something peculiar going on above them. But if they pull the ropes in proper time, they can either quiet these adynamic vibrations or strengthen them, so that in this case these co-ordinates cannot be ignored.

There are other cases, however, in which the conditions for the ignoration of co-ordinates strictly apply. For instance, if an opaque and apparently rigid body contains in a cavity within it an accurately balanced body, mounted on frictionless pivots, and previously set in rapid rotation, the co-ordinate which expresses the angular position of this body is one which we are compelled to ignore, because we have no means of ascertaining it. An unscientific person on receiving this body into his hands would immediately conclude that it was bewitched. A disciple of the northern wizards would prefer to say that the body was subject to gyrostatic domination.

Of the sections on cycloidal motions of systems, we can only here say that the investigation of the constitution of molecules by means of their vibrations, as indicated by spectroscopic observations, will be greatly assisted by a thorough study of this part of the volume.

We have not space to say anything of what to many readers must be one of the most interesting parts of the book—that on continuous calculating machines, in which pure rolling friction is taken from the class of unavoidable evils, and raised to the rank of one of the most powerful aids to science. Rolling and sliding have been more than once combined in the hope of obtaining accurate measurements, but the combination is fatal to accuracy, and these new machines, one at least of which has been actually constructed and used, are the first in which pure rolling friction has had fair play given it as a method of mechanically accurate integration.

A method is also given of combining a number of disk, globe, and cylinder integrators, so as to form a machine the motions of two pieces of which are related to each other by a differential equation of any given form. These machines all work in a purely statical manner, that is, in such a way that the kinetic energy of the system is not an essential element in the practical theory of the machine (as in the case of pendulums, &c.), but has to be taken into account only in order to estimate the magnitude of the tangential forces at the points of contact which might, if great enough, produce slipping between the surfaces. Thus, by means of a machine, which will go as slowly as may be necessary to keep pace with our powers of thought, motions may be calculated, the phases of which in nature pass before us too rapidly to be followed by us.

In the original preface some indications were given of what we were to expect in the remaining three volumes of the work. We hope that the reason why this part of the preface is omitted in the new edition is that the work will now go on so steadily that it will be unnecessary to preface performance by promise.

J. CLERK MAXWELL

ARTIFICIAL MANURES

On Artificial Manures, their Chemical Selection, and Scientific Application to Agriculture. A Series of Lectures given at the Experimental Farm at Vincennes, during 1867 and 1874–5. By M. Georges Ville. Translated and Edited by W. Crookes, F.R.S. (London: Longmans and Co., 1879.)

THOSE who take up this volume with the hope of finding the chemistry of artificial manures fully treated will be much disappointed. Not only are many of the commonest manures scarcely mentioned, but some of the most important and practical aspects of the subject are never noticed. The behaviour of manures after they come in contact with the soil is surely of the greatest importance. Chemical investigations have long ago proved that some of the ingredients of manure—as phosphoric acid and potash—are firmly held in combination by the soil, while others—as nitric acid, chlorine, and soda—are feebly retained, and readily pass away in the drainage water after rain. It has also been abundantly proved that though ammonia is firmly retained by a fertile soil, it rapidly undergoes conversion into nitric acid, which is easily washed out. The practical conclusion from these facts is plain. Diffusible manures must be applied only when the crop can make immediate use of them. Now, though M. Ville speaks voluminously concerning the application of phosphates, nitrates, and ammonium salts, no reference to the facts just indicated is to be found in his book, beyond the mere statement that clay is capable of temporarily retaining potash and ammonia.

The lectures of M. Ville are chiefly occupied by the consideration of the present state of agriculture in France, and by the recommendation of a system of artificial manuring of which he regards himself as the inventor. The condition of French agriculture is clearly, as a whole, very low; the existence of the peasant and small farmer is only maintained by the exercise of much thriftiness and self-denial. To improve this condition M. Ville very

properly recommends the consolidation of the land in large farms, and the liberal use of artificial manures.

The "normal manure" which M. Ville recommends is in its simplest form a mixture of superphosphate, saltpetre, and gypsum, thus supplying nitrogen, phosphoric acid, potash, and lime. Instead of employing the nitrate of potassium, a mixture of nitrate of sodium or sulphate of ammonium with chloride of potassium may be substituted; the manure then becomes a "normal homologous manure." This normal manure embraces all the chief elements of plant food which it may be necessary to apply to the land. It is unnecessary, however, to apply the entire mixture to every crop. Each crop demands a preponderance of one or other of the constituents of the manure; this "dominant" constituent is therefore increased when the manure is prepared for a particular crop; or the elements of the whole manure may be distributed through a rotation of crops, each crop receiving the part specially suited to it. Stated thus, we can only approve the recommendations which M. Ville has made; they are in fact, in their last-named form, precisely carried out by all our best farmers in the present day. Though, however, we have correctly stated the teaching which may be gathered from his book, there are many passages in the lectures which urge the return to the land of all the potash, phosphates, and lime which the crops have removed, a proceeding which is on many soils quite unnecessary, and therefore, very unremunerative.

M. Ville recommends that each farmer should set aside a small portion of his land to be treated with experimental manures. One plot of this ground would receive the normal manure; a second the same without nitrogen; a third the same without phosphates; a fourth the same without potash; while another plot would be left entirely without manure. By growing crops on these plots the farmer would learn in the most certain manner what elements of plant food were chiefly deficient in his soil in relation to the crops he wished to grow. This is excellent advice; no better could be given. It is only by such experiments that the true condition of the soil can be revealed; and it is only by thus testing the effect of manures before applying them on a large scale that an economic return can reasonably be expected. France is apparently ahead of us in the practical use of such experiments. Thanks to the centralisation which places the control of everything in the hands of the Government, field experiments of this description are now in progress in thirty-four farming schools throughout the country, while simpler experiments on the effects of manures have been established in connection with 350 day schools. In England we have but one place at which such experiments are thoroughly carried out, namely, Rothamsted.

Are we, then, to credit M. Ville with the discovery of the great effect to be obtained from artificial manures, or of the best mode of applying them? He claims for himself the honour of having discovered the principles he sets forth, and compares himself with Lavoisier, and his detractors with the detractors of that great man, and concludes:—"We must allow time to complete the work of justice, and give to every one his proper place." We will in reply simply mention a few dates. The famous field experiments at Rothamsted commenced in 1843; in the very first year trials were made of the effects of phosphates, potassium, magnesium, and ammonium salts. These field experiments have been carried on continuously up to the present time, and the effect of every variety of combination of manure has been shown in the fields devoted to wheat, barley, beans, clover, roots, pasture, and potatoes. That nitrogen should form the "dominant" constituent of a manure for wheat, and phosphates the dominant constituent of a manure for turnips, was clearly proved in the first two or three years of the experiments; and by 1849 the character of potash as the proper dominant in the case of beans and clover was also established. With these experiments M. Ville is well acquainted. Our last date shall be taken from his own book. The first field experiments made by M. Ville at Vincennes commenced in 1860.

The book contains several extraordinary statements. It would take too long to discuss M. Ville's views as to the assimilation of the free nitrogen of the air by all crops, but especially by the leguminosæ; immense quantities of nitrogen are, according to him, thus acquired. We are curious to know what authority he has for stating that when an animal is fed on hay one-third of the nitrogen is lost "in the act of digestion," and that another third is lost during the fermentation of the animal manure, so that only one-third of the original nitrogen is at last returned as manure to the land.

We cannot conclude without calling attention to the extremely untrustworthy character of the figures throughout the book. On p. 54 the mould on an acre of soil weighs 400,000 tons; on p. 180 it weighs 1,600 tons. On p. 353 the weight of resin yielded by an acre of pine trees is given as 4–5 cwts., but immediately after it is stated to be 1,122–1,540 lbs. The quantities of nitrogen to be applied are a complete puzzle. To take a single instance: On p. 238 we are told that to obtain a good crop of beet we must apply 70 lbs. of nitrogen per acre. On p. 357 the quantity has risen to 176 lbs. On pp. 367 and 368 the formulæ for the beet manures are given; each formula is stated to contain 187 lbs. of nitrogen; but on looking at the ingredients only 83 and 85 lbs. of nitrogen are found to be contained by the ammonium salts and nitrates employed. Finally, on p. 374 we are told that the nitrogen applied to beet should amount to 70–88 lbs. per acre. What are we to believe?

Both the old and new chemical notations are employed in the course of the book. R. W.

OUR BOOK SHELF

Lecture on the Gault. By F. G. H. Price. (Taylor and Francis, 1879.)

THIS pamphlet contains considerably more than a lecture, embodying a list of the French and English works upon the Gault, which have come under the author's notice, and nearly forty pages of tables of fossils.

The description of the gault at Folkestone has been amplified from that read by the author before the Geological Society.[1] He maintains his subdivision of the gault at Folkestone into beds, and endeavours to correlate with them, to some extent, the gault to the west. The outcrop at Eastbourne is separately described, and found to contain an unexpectedly long list of fossils. The Blackdown beds are included in the Gault, which is to be greatly regretted, for there is every reason to suppose that

[1] *Quart. Journ. Geol. Soc.*, 1874, vol. xxx. p. 342.

they are of much newer, and most probably upper greensand age: to tabulate their fauna with that of the gault, lessens the working value of the tables materially. The upper gault only is thought to be present in the Isle of Wight, where it is 100 feet thick. The little that is known of the gault in the Midland Counties is collected together, and that of Cambridgeshire and the red chalk at Hunstanton is briefly described. A few pages are devoted to the gault in France, a few lines to that of Switzerland, but no mention is made of any equivalents in Germany or in Belgium. The pamphlet contains in a compact form a deal of information upon the gault, which would have to be sought elsewhere in many publications, and it may prove of value to students at home and abroad.

The author believes that the bands which are characterised by fossils peculiar to them at Folkestone, can be traced elsewhere in England and in France. The range through the gault of most fossils is probably less restricted than is imagined, but some species are apparently strictly confined to narrow zones at Folkestone, although closely allied species abound in cretaceous rocks in England, and even America. It is likely that zones of fossils were due to the gradual alteration of depth which enabled certain gregarious forms to exist on the spot for a very short time only after their first migration to it. Their presence elsewhere would not prove that the zone was a continuous one; it would only indicate that at some period, not necessarily a synchronous one, the sea at that other spot had fulfilled the conditions of depth, &c., under which alone the particular species could exist. The same view applies to the idea that upper gault only was deposited in the Isle of Wight. There is no reason to suppose that deposition did not proceed there in the lower gault age, and it is more probable that the sea was, during the whole gault period, only fitted to receive that form of silt, and those fossils which are known at Folkestone as upper gault. The lower gault is spoken of by the author as a shallow sea deposit gradually deepening to the chalk, but the President of the Geological Society has stated his opinion that the gault is an extremely deep sea deposit, while Mr. Gwyn Jeffreys has collected much evidence to prove that the chalk was formed in shallow water. Whether we accept them or not, the views of such distinguished men should find a place in a work intended to be exhaustive.

Travels and Researches among the Lakes and Mountains of Eastern and Central Africa. From the Journals of the Late J. Frederic Elton, H.B.M. Consul at Mozambique. Edited and Completed by H. B. Cotterill. Maps and Illustrations. (London: Murray, 1879.)

ONE cannot read Consul Elton's Journals without feeling how great a loss his death has been not only to the cause of the native African, but to African exploration. Elton was only thirty-seven years of age when he succumbed to the hardships of African exploration, but he had already done more than his share of hard and useful work. The handsome and beautifully illustrated volume before us deals with his observations and adventures in Africa from 1873, when he went to Zanzibar as Vice-Consul to his death in December, 1877, when trying to push from the north end of Lake Nyassa to the coast at Dar-es-Salaam. Much of the earlier part of the volume tells of the work Elton did in putting down the slave-trade in the dominions of the Sultan of Zanzibar. In carrying out this work he had to visit most of the coast from Zanzibar to beyond Mozambique, as well as Madagascar, and with the details of his more immediate mission, is mixed up a good deal of geographical information. He carried on his works of benevolence and exploration on his appointment as Consul of Mozambique. The chief novelty of the volume, however, is in the second part, in which the story of the journey from the north end of Lake Nyassa north-east to the coast is told. Here Elton, Cotterill, and their companions broke on fresh ground, and made substantial additions to our knowledge of African geography and African people. With the main results of this journey we are already familiar, through the description of Mr. Cotterill at the Geographical Society and elsewhere. Elton left Mozambique in July, 1877, Livingstonia at the south end of Nyassa in September, and the north end on October 15. The country traversed was mainly hilly, rising in the Konde Mountains, north-west of Nyassa, to 12,000 feet. Elton speaks of the country as the "Garden of Africa." The party were delayed for a time in Merere's Country in the Konde Mountains, by one of those little wars, which so often embarrass African explorers, and during the delay some hardships had to be endured, which no doubt told on Elton's health. On December 19 he succumbed to what seemed sun-stroke, and was buried under the shade of a baobab in South Ushekke. Cotterill conducted the expedition to Bagamoyo, over what is comparatively well-known ground. In completing the narrative of the expedition and editing his late fellow-traveller's journals, in preference to publishing a narrative of his own, he has acted with an unselfishness which deserves to be acknowledged. The book is altogether one of much interest. The Rev. A. E. Eaton contributes a short Appendix on the Natural History of the Kungu Fly, out of which the natives to the north of Nyassa make cakes.

Conic Sections—The Method of Projections. By Rev. S. Bolton Kincaid, M.A. (London: Stanford, 1877.)

THIS book has only recently met our notice; it consists of a series of twenty-nine propositions deriving proofs of many of the chief properties of the ellipse by the method of circular projection. We have not come across any special novelty in the little book, nor have we detected many mistakes, though the lettering, from the use of like letters, we have found in many cases confusing. The figures face the text, and the circle figure is over the elliptical one; they are in many cases very roughly turned out by the engraver.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Comet 1879 *c* (Swift)

THE following observations may be useful to some of your readers:—On June 25 the comet was compared five times with the star O.A. 3268, with a ring micrometer (power 35); on June 28 it was compared eight times with the star Dm $+71°$, 184 by means of a bar reticule with power 70. The comet has a bright spot near the centre which, on June 25, seemed to me to be nearly equal to a ninth magnitude star; bnt on June 28 it was much fainter, although easy to observe with precision after 11h. 30m. The diameter appears to be 2′ or 3′ in my telescope (of $4\frac{1}{2}$ inches aperture) but I cannot see any trace of the tail mentioned by Mr. Swift. The comet is, however, immersed in the twilight now existing at midnight.

1879.	G.M.T. h. m. s.	Appt. R.A. h. m. s.	Appt. Dec. ° ′ ″
June 25	11 57 49	2 49 37·1	+ 68 41 37
June 28	11 30 20	2 51 13·3	+ 71 52 18

1, Vanbrugh Park, Blackheath G. L. TUPMAN

The Mechanical Theory of Earth-Heat

IN reference to Mr. J. P. Lesley's inquiry as to whether plicated coal-beds are generally converted into anthracite, it has occurred to me that during a residence upon the Somersetshire coal district, thirty years ago, I recollect visiting the Vobster coal-pits, on the northern edge of the Mendip hills. The coal-seams are there exceedingly disturbed. One seam of coal was

said to have been pierced three times by a vertical shaft. Yet the coals are not anthracite. The Vobster pits are very fiery. The Radstock pits, where the coal is horizontal, not so; but they are worked in higher beds.

By reference to the Commissioner's report to Parliament, 1871, it will be seen (p. 38) in Mr. Prestwich's report on the Nettlebridge Valley coals, where Vobster is situated, that my recollections are confirmed; "bituminous coal" and "disturbed condition" being alike attributed to these coal beds.

With respect to the general question of the mechanical theory of earth-heat, I would respectfully refer Mr. Lesley to my examination of the theory in the *Philosophical Magazine* for October, 1875. O. FISHER

Harlton, Cambridge

On the Origin of Certain Granitoid Rocks

IN a paper by me "On the Pre-Cambrian Rocks of Shropshire," read before the Geological Society on the 11th inst., I call attention to certain granitoid and gneissic rocks in Primrose Hill, at the south-west end of the Wrekin. Associated with these metamorphic strata in such an irregular manner as to suggest an eruptive origin is a compact felspathic rock with minute quartz grains, which I at first presumed to be a quartz felsite. On submitting specimens to Prof. Bonney, F.R.S., for microscopic examination, he declared the rock to be clastic, and closely allied to the hälleflintas, which Dr. Hicks assigns to his Arvonian group. Certain observations recently made in south-west Shropshire, suggested to me a transition between the hälleflinta and the granitoid types, and, on communicating my suspicions to Prof. Bonney, he stated that a similar connection had been suggested by his microscopic examination. This morning I hammered over Primrose Hill foot by foot, and I have the satisfaction of announcing the fullest confirmation of our suspicions. In the same block, the compact hälleflinta is frequently mixed up with granitoidite and hornblendic gneiss. In some cases, the metamorphism has taken place only near the surface, as if produced by atmospheric agencies; in others the crystallisation occurs in nests, while in others there is a gradual transition in mass from a compact to a granitic structure. This passage of hälleflinta into granite has obviously important theoretical applications.

Wellington, Salop, June 21 C. CALLAWAY

Migrations of Birds

I NOTICED some time ago a communication in NATURE respecting this subject, stating that it would be instructive and interesting alike if naturalists would record any data they may have collected on this subject. For years now this matter has had my careful attention, and I therefore forward a few notes for the last two seasons, and also put forward the hope that observers stationed in other parts of the United Kingdom will contribute information of a like nature. I would also say that the weather noted applies to the night—the time, by the way, generally chosen for migratory movements.

Vernal Migration, 1878

Dates.	Species.	Remarks.
April 4	Gray Wagtail	In pairs on the trout streams for nesting season. Weather clear, warm westerly breezes.
,, 4	Tree Pipit	In full song and seen for first time; westerly breezes.
,, 15	Redstart	In full song in Encliffe Wood and Rivelin Valley; warm westerly breezes, clear.
,, 15	Willow Warbler	Numerous, arrived during last night.
,, 15	Ring Ousel	Numerous and full of song.
,, 18	Chiffchaff	In small numbers, westerly breezes, very warm, close.
,, 19	Swallow	One specimen seen; westerly breezes, fine and clear.
,, 19	Cuckoo	Heard and saw flying over the busiest streets of Sheffield at 4.30 A.M.
,, 22	Whitethroat	One heard; dull and misty drizzling rain, W.S.W.
,, 22	Martin and Sand Martin	Numerous, in company with swallows in the Derwent Valley.
,, 28	Blackcap Warbler	First seen, but silent; warm breezes, S.E.S.
,, 29	Whinchat	Seen for first time, weather dull, S.E.S.
,, 29	Common Sandpiper	Seen for first time, in pairs, in Rivelin Valley.
May 3	Landrail	First heard, weather dull and gloomy, W.
,, 6	Spotted Flycatcher	First seen, very wet night, wind direct, S. These birds are still solitary.

Vernal Migration, 1879

Dates.	Species.	Remarks.
Feb. 10	Song Thrush	Arrived in night; dark and cloudy, wind W.
,, 10	Blackbird	Arrived in night; dark and cloudy, wind W.
March 20	Yellow Wagtail	Numerous.
,, 20	Pied Wagtail	,,
,, 29	Willow Warbler	One specimen seen, somewhat feeble, silent; wind W. by S., night dull and showery, snow only left ground day before. Never known this species so early before. Average time being April 5.
,, 29	Greenfinch	Again in usual haunts after being entirely absent during the winter, with the exception of one pair seen in a garden in Sheffield.
April 9	Chiffchaff	Saw and heard in young fir plantations at Hollow Meadows, S.W. and westerly winds.
,, 21	Curlew	In pairs at breeding grounds on moors.
,, 21	Ring Ousel	Numerous on moors, mostly in pairs; no song.
,, 24	Tree Pipit	Arrived; dull and showery weather, easterly winds.
,, 26	Willow Warblers and Chiffchaffs	On the evening of 25th not a bird was seen; on morning of 26th the birds abounded and their cheery notes are heard on every side. The night was dark and showery (new moon), wind S.
,, 26	Cuckoo	Heard in Lees-hall Wood. This bird has arrived during past night, doubtless in same flight as willow warblers, &c.
,, 28	Swallow	Seen in Meersbrook Park; weather showery and dull, wind light from S.W., moonlight.
,, 29	Whinchat	Seen in Meersbrook Park; weather showery and dull, wind light from S.E., moonlight.
May 2	Wheatear	On moors, full of song.
,, 2	Common Sandpiper	Rivelin and Redmires dams, in pairs. This species has been here some few days.
,, 2	Redstart	This bird has now arrived, but only seen in small numbers. Cold easterly winds, moonlight.
,, 5	Wryneck	Saw on Rivelin moors; solitary and uttering its whistling notes. Cold easterly winds.
,, 8	Landrail and Whitethroat	Heard in meadows; very scarce; probably came last night with a cold south-westerly breeze.
,, 12	Sand Martin	Skimming over the waters in small numbers. This species is remarkably late; wind N.W. by W.
,, 13	Blackcap	Singing in densest covers, and very shy. This species is very late. South-westerly breeze, clear night.
,, 17	Martin	Saw a pair of these birds; they are very late as compared with previous seasons. Southerly breezes and very showery.
,, 24	Swift	One seen on the borders of the Rivelin Moors. South-westerly breezes and very showery.
,, 26	Spotted Flycatcher	One specimen seen, silent and somewhat wary. N.W. by W., light, and showery moonlight night.

Such are a few extracts, taken *verbatim*, from my note-book; they might have been considerably increased, and the time of departure noted, as well as the arrival of our winter migrants, but I fear I have already trespassed too greatly on your valuable space. I sincerely trust that this interesting subject will be more fully discussed and studied by your correspondents and readers; for in that way many of the difficulties enshrouding the movements of the feathered tribes will be overcome.

Heeley, near Sheffield, June 9 CHARLES DIXON

Glow-worms *v.* Snails

YOUR correspondent, Mr. R. S. Newall, has unconsciously reversed the natural condition of affairs in his note (NATURE, vol. xx. p. 197). The heading should have been as above. Glow-worms *devour* snails, which are their natural food. The particular snail in question had probably been attacked by one of the glow-worms, which had left some of its phosphorescent matter adhering to it, and this occasioned the idea that it was showing through the body of the mollusk. Possibly in this case the snail may have proved too large for the glow-worm. An allied insect, *Drilus flavescens*, somewhat rare in this country, and not luminous, is, so far as the female is concerned, seldom

found excepting inside the shells of species of *Helix*, the animal of which it had previously devoured. R. McLachlan

Lewisham, June 27

Your correspondent, R. S. Newall, is upon the wrong tack, I think. His glow-worm was probably eating the snail, and not *vice versâ*.

In Kirby and Spence's "Entomology" I read: "Snails give sustenance to *Drilus flavescens*, a beetle, and its singular apterous female in the larva state, as well as to the larvæ of glow-worms." Is it not probable that the same food suits the imago state of the insect?

I have often found glow-worms in snail shells, and have always considered slugs and snails to be the natural food of the *Lampyris noctiluca*. R. Greenwood Penny

Bishopsteignton, Devon

Frogs and Glow-flies

Mr. Newall may be, perhaps, interested with the following extract from Darwin's "Botanic Garden," Canto iv. p. 149, note:—

"In Jamaica, in some seasons of the year, the fire-flies are seen in the evenings in great abundance. When they settle on the ground, the bull-frog greedily devours them; which seems to have given origin to a curious, though cruel method of destroying these animals; if red-hot pieces of charcoal be thrown towards them in the dusk of the evening, they leap at them, and, hastily swallowing them, are burnt to death."

I was told a few days ago of a cat which used to search for and eat glow-worms. It was suggested that she took them for *lights*. George Henslow

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Intellect in Brutes

The following instance of sagacity in a cat has just been related to me by a friend who knew both the cat and its owner well. The latter, who lived at Ragusa Vecchia, in Dalmatia, was too poor to be able to provide food for the cat; the animal was therefore obliged to cater for himself, and was well known as a thief in the neighbourhood. One day one of the children was being sent off to school without any breakfast; the cat, hearing him sobbing for hunger, immediately went off, and returned with a piece of bread he had stolen from a baker hard by, and brought it to the child. The same thing happened another day, and he came back, dragging along a piece of meat bigger than himself. On crossing the threshold a bit of bone caught in a hole, so puss miawed till some one came to his help. This same cat, who was constantly catching birds on the roof, slept with some pet birds in a cage without attempting to touch them.

Ragusa, Austria, June 18 Margaret Evans

I send you the following instance of intelligence in dogs:— Last summer, when on a visit at the château of my son-in-law, M. Richard Waddington, Deputé, near Rouen, I had taken a walk in the grounds, accompanied by some of the family, and two favourite dogs, named respectively Minos and Rhadamanthus, followed the party, as usual, throughout the stroll. When nearing the house, on the return, my young grand-daughter remarked that Minos had lost his collar. The party came to a halt, debating whether it was worth while to go back on a searching expedition, for the pleasure grounds are somewhat extensive, and the dogs had been rambling away from the paths among long grass. Both Minos and Rhadamanthus evidently seemed to listen to the debate. It was decided to make the search at a venture, and, without saying a word to the dogs, the party commenced to retrace their steps. As a rule, these two dogs are inseparable; wherever the one goes the other goes, and invariably the two follow any members of the family when strolling about the place. At this juncture, however, Rhadamanthus, not having lost a collar, and having no special interest in the proposed search, went on her solitary way home to the stables; but Minos kept with the party, walking on the gravel path—and this for some distance—when suddenly he took to the meadow, commenced running, and presently he was observed to stop and remain fixed with his head pointed downwards, partly buried in the tall grass. Naturally he was followed. The point of his nose was in contact with the collar! Could any child of man, under similar circumstances, have displayed more *thoughtful sagacity* than did *each* of the above dogs on thé above occasion? The one thought she was not wanted, and having had enough play, wisely went home, whilst the other, thinking that his presence was requisite, wisely returned with the searching party.

When in Bute, some years ago, I heard from a gentleman, perfectly trustworthy, that a large Newfoundland dog, belonging to a friend of his, was observed one night by its owner lying concealed under his bed—a strange circumstance, because the dog was forbidden to enter the house at night. The owner, being struck by this singular occurrence, resolved not to disturb the creature, and, getting into bed, kept himself awake to watch events. It was not long before a sound was heard in the passage, a faint light was seen through the key-hole, the door opened, and instantly the dog flew from under the bed, and, springing forward, brought a man to the ground, the gentleman's own servant, who, accompanied by another fellow, was there for the purpose of robbery. Chas. Popham Miles

Vicarage, Monkwearmouth

Having read Mr. Peach's letter on "Intellect in Brutes," as shown by the sagacity he witnessed in his dog, I have been asked to send a similar anecdote, which I have often told to friends. Many years ago my husband had his portrait taken by T. Phillips, sen., R.A., and subsequently went to India, leaving the portrait in London to be finished and framed. When it was sent home about two years after it was taken, it was placed on the floor against the sofa, preparatory to being hung on the wall. We had then a very handsome large black and tan setter, which was a great pet in the house. As soon as the dog came into the room he recognised his master, though he had not seen him for two years, and went up to the picture and licked the face. When this anecdote was told to Phillips, he said it was the highest compliment that had ever been paid to him. X.

Some years ago a fine arts exhibition was held at Derby. A portrait of a Derby artist, Wright, was thus signalised: "The artist's pet dog distinguished this, from a lot of pictures upon the floor of the studio, by licking the face of the portrait."

Derby Henry Clark

Butterfly Swarms

With reference to the swarms of butterflies referred to by M. Forel, in Nature, vol. xx. p. 197, it may be interesting to mention that *Vanessa cardui* is this year very common in the south of England. This butterfly is known to all English lepidopterists to be "periodical"—in some seasons it occurs in great numbers, in others—perhaps for several years in succession—not one specimen is to be seen.

Last season (1878) I saw no specimens, nor did I hear of any about here. It seems, therefore—in such a bad season for insects as the present—impossible to consider the abundance of the species in England to be the result of "local fecundity." Whence, therefore, come these specimens? and is the periodical abundance of the species in Britain due to local causes or migration? J. H. A. Jenner

4, East Street, Lewes, July 1

THE KILBURN SHOW

It is difficult to estimate the disadvantages with which the Agricultural Exhibition at Kilburn has had to contend. So large a show must always be somewhat unwieldy, however skilfully planned, but the melancholy wet season has enormously increased the difficulties of arrangement, and we may add that fairly to study the implements and miscellaneous exhibits was quite impossible up to the time of our going to press. A few jottings set down at random concerning such instruments, operations, and specimens as drew our attention while in the yard on Monday must suffice on the present occasion. Visitors were supposed to view the exhibits from the avenues between the long rows of sheds; but these avenues, once grass, were transformed into roads of mud, in every condition of matter between the solid and liquid states. There were no paths across the sheds, and as most of the implements and other exhibits were not so arranged as to be approachable on more than one side, the difficulty of examining objects of interest was frequently insurmountable.

Perhaps the comparative loan collection of farm implements is the most noticeable feature of the whole show. The paucity of labels and the filthy condition of the ground notwithstanding, the rollers, ploughs, harrows, drills, threshing, winnowing, and reaping machines, are full of interest. Of the actual specimens shown, but few, if any, date back further than the last century, while the majority belong to the first half of the present. The reapers, including Bell's reaper of 1826, form an instructive series.

When, about the year 1850, steam was becoming more generally used for agricultural operations, an immense impetus was given to the improvement of farm machinery. Richard Trevithick's portable engine, made at Hayle Foundry, in 1811, and put upon Sir C. Hawkins's farm at Trevithen for working a threshing machine, is an historical agricultural relic far too curious to be allowed to return, after the Kilburn Show is closed, to its prosaic duties in Cornwall. It should be secured for the Patent Museum at South Kensington. It must be regarded as inaugurating the practical use of steam on the farm. The later steps in the progress of steam cultivation may be studied in this loan collection and in the modern implement sheds with tolerable completeness.

Before leaving the subject of the loans exhibited at Kilburn, we may direct our readers to a case exhibited by the Secretary of State for India. It is to be found close to the house in which the plans for farm-buildings are arranged, and in a line with one of the historical [implement sheds. The case in question contains specimens of wheat from our Indian Empire, and is accompanied by a map, some remarks on the quality of the wheats, and some statistics. From the latter we learn that India produces 40 million quarters of wheat, of which but 1·3 millions were exported in 1877; that the demand for wheat of the whole world is at the most but 25 million quarters; and that the United Kingdom requires an average import of 11 million quarters, in addition to her home production of the same quantity. Had chemical analyses of some of these samples of Indian wheat, together with their mill-products, been added to this exhibit, it would have been still more instructive.

In the same shed with the Indian wheats there are shown a series of seventeen cases illustrative of the composition and nutrition of the human body. These are lent by the South Kensington Museum and from what is known as the "Circulating Food Collection." It constitutes a small replica of the most characteristic parts of the Food Collection at Bethnal Green, and like the latter, has been arranged and fully described by Prof. Church. It supplies in an exact yet popular form an immense amount of information concerning the elements and compounds of the human body and of food; and concerning the amount and nature of a day's ration, the equivalents of foods, the analysis and adulteration of alimentary products, the qualities and testing of waters. It has been lent to several provincial exhibitions already, and forms an admirable instrument of popular instruction.

Turning to another department of the show we notice, amongst the raw materials used in the manufacture of manure, some specimens of native phosphates which claim our attention. The search for anything that can be made into superphosphate has certainly been most exhausting. As one supply fails a new one is discovered. The Canadian apatites shown at Kilburn are very fine. Some hexagonal prisms and pure blue crystalline masses are quite museum specimens. Some samples of what are called Russian coprolites are exhibited on Stand 615. They are large and have a well-marked radiate structure, closely resembling that often seen in iron pyrites.

We do not recollect ever having before seen the seed of the locust bean, *Ceratonia siliqua*, prepared for food by simple splitting, as shown in a fine sample (No. 11,081) on Stand 595. Some specimens of selected or pedigree wheat, on Stand 629, are noticeable.

The artificial drying of hay and some other crops is likely to be more extensively employed before long. Mr. W. A. Gibbs, the inventor, shows some improved forms of his implement for this purpose. They effectually get rid of the excess of moisture in the materials submitted to the process of artificial desiccation without stewing them. One machine can dry out 35 per cent. of water from hay at the rate of twenty loads a day. Another instrument, of which a model is also shown, is specially adapted for drying tea, coffee, manures, hops, and fruit.

It is impossible to do justice, in a single set of brief jottings like the present, to any of the subjects we have handled. We can but direct attention to some of the characteristic features of the stands, and to two or three out of the thousands of specimens shown. We should like to have dwelt upon numbers of inventions to which we have no space to allude; but we cannot refrain from noticing the exquisitely ingenious application of hydraulic pressure to the automatic opening, and, what is more curious, the automatic closing, of entrance gates by the pressure of the passing vehicle. The interval between the opening and the spontaneous closing of these gates can moreover be regulated to a nicety by a previous adjustment. A large working model of this invention will be found at Stand 141, the patentee being W. Walton, of Runiley, Manchester. We must also note a charming chromolithographic diagram of the colours acquired by the metal in tempering steel from the pale straw proper to "scrapers for brass" through shades of orange, red, and purple to the deep blue of "springs." This was issued as a supplement to the *Ironmonger* of April 5, 1879, and is shown at Kilburn on the stand appropriated to that paper.

We have not space to speak of the many admirable features of the showyard, nor even of the delightful little train of steam tramcars working on rails of less than two feet gauge. But we may return to the subject of the Kilburn Show next week.

MAJOR PINTO'S AFRICAN JOURNEY

MAJOR SERPA PINTO has been lecturing in Lisbon to a distinguished audience on his journey across Africa from Benguella to Durban. He apologises for the disjointed character of his lecture, for which he had no time to prepare, and which, therefore, cannot be taken as anything like a complete account of the results of his journey. There is some likelihood of his soon being in London, and probably then he may give us a more systematic account of what he has been able to gather in the interesting region through which he passed. A good deal has been said of the large natural history and other collections he has made, and if these be such as they have been represented, science will certainly be much indebted to the gallant Major, who has tried to revive the glories of the old days when Portugal was in the front rank of exploring nations. A good many difficulties were met with at the beginning as usual, and Major Pinto deemed it advisable to separate himself from his companions Ivens and Capello, who took a more northern route, and as they had various scientific instruments with them, including such as were suitable for observations in terrestrial magnetism, possibly they may have some important contributions to make to science.

It is difficult to make much out of Major Pinto's rambling talk, which often reminds us of the vague and wonderful stories told by the simple travellers of old. He certainly seems to have made important rectifications in the hydrography of South-West Africa, especially of that flat table-land about 12° S. and 18° E., where within a few paces one can drink of the water of the sources of the Zambesi, Coanza, and Cubango, and where it can easily

be conceived that in wet seasons the oozing waters will have some difficulty in making up their minds whether to take their course to the Atlantic, the Indian Ocean, or by the Cubango south to the sands of the Kalahari Desert. Major Pinto's real starting-point was Bihé, the eastern limit of Portuguese West Africa. Going south and east by the Kalahari Desert, through the Transvaal, he came upon the scene of the Anglo-Zulu strife, and was safely carted to Durban. He suffered the usual hardships of desertion by followers, starvation, fighting hostile tribes, and narrow escapes from cataracts. To the west of Bihé he discovered the source of the Cubango, which, he states, loses itself in the Kalahari Desert, after overflowing to form Lakes Ngami and Macaricari, the latter of which is sometimes dried up. There is no connection, he says, between the Cubango and Cuando, the latter, after receiving many feeders, finding its way to the Zambesi, where, at its mouth Livingstone gave it the name of Chobé. A good deal of his information Pinto seems to have derived from a map drawn by a Bihé native. The river Cuqueima, he tells us, is an affluent of the Coanza, west of the Cubango. At its source the Cuando is a little rill, but soon becomes navigable, many of its tributaries being navigable also. Going through Ungo-é-Ungo, between the Cuango and Upper Zambesi, he found the ground all miry, an immense marsh; "water covered everything." From the Bihean's map he found that the most southern source of the Lualaba lies between those of the Liambai, or Zambesi, and the Luengué, and in 12° S. lat., "like those of the other rivers of Africa." The Luengué, or Cafuque, the "Cafue" of Livingstone, a tributary of the left bank of the Zambesi, the Major states, has not a single cataract, and should form the real key to Central Africa. The river that connects Lakes Bangweolo and Moero, he states, is not the Lualaba, but the Luapula; did not Livingstone say so? Lualaba, Pinto says, is the name given to the west arm, which extends to 12° south, and must be considered the real source of the Congo, and not the Chambeze, which enters the east end of Lake Bangweolo. On a recent map of Africa, we find the Lualaba placed as described, and as to which is the source of the Congo, it is a matter of opinion as to what "source" means.

The Zambesi seems to be more notorious for cataracts than even the Lualaba—Congo; Pinto and his men descended thirty-seven; he saw thirty in the space of an hour and a half "that had never been mentioned by any one."

At the junction of the Cuando and Zambesi, Major Pinto found an English naturalist from the Cape, Dr. Bradshaw, "who was reduced to the greatest misery," wandering about barefoot, and carrying in his hands a pair of shoes, with only a tattered shirt and a pair of trousers on. Dr. Bradshaw's extreme misery he seems to have borne with equanimity; he gravely presented his carte-de-visite, taken in London, to his Portuguese fellow-explorer. He was shooting birds and collecting animals for "the English museums." Near the same place a French missionary family befriended the sorely beset traveller, and helped him out of his difficulties. At the beginning of his journey, at Caconda, he met another naturalist, a Portuguese, Anchietta, who has been twelve years in Africa, and "has enriched one of the best African museums in the world, that of the Lisbon Polytechnic School, which is under the direction of Dr. Bocage." Have the treasures of this African Museum ever been described? Anchietta was more fortunate than the miserable English naturalist, who received the major in his drawers. The Portuguese, on the contrary, received his compatriot "in the woods, wearing a white necktie and a dress coat, and offered us tea in cups of porcelain of Sèvres." Still Anchietta, with all his attention in the wilds of Africa to the usages of ceremonious Europe, seems to be a hard-working naturalist.

The only other point in Major Pinto's lecture we need notice is his observation as to a race of white Africans, which will recall to the reader what Stanley says about the white inhabitants of the lofty mountain near the Albert Nyanza. We shall let the Major tell what he observed for himself:—

"I one day noticed that one of the carriers was a white man. He belonged to a race entirely unknown up to the present day. A great white people exists in South Africa. Their name is Cassequer; they are whiter than the Caucasians, and in place of hair have their heads covered with small tufts of very short wool. Their cheek-bones are prominent, their eyes like those of the Chinese. The men are extremely robust. When they discharge an arrow at an elephant the shaft is completely buried in the animal's body. They live on roots and the chase, and it is only when these supplies fail them that they hold any relations with the neighbouring races, the Ambuelas, from whom they obtain food in exchange for ivory. The Cassequeres are an entirely nomadic race, and never sleep two nights in the same encampment. They are the only people in Africa that do not cook their food in pots. They wander about, in groups of from four to six families, over all the territory lying between the Cuchi and the Cubango. It would seem that from a crossing of the Cassequeres with the negroes of other races, sprang those mulattoes of the South whom the English call bushmen. The latter are, however, better off than the Cassequeres, and use pots in cooking their food, while their dispositions are good, though quite opposed to civilisation."

We cannot doubt the accuracy of the Major's observations, though we should require to know more of the curious people he speaks of before pronouncing on their origin and affinities.

Altogether it will be seen that Major Pinto, while hardly having a claim to be ranked among "the foremost of explorers," has done a piece of good and useful work amid a good many dangers, work creditable to himself and his country, which, we trust, will be stimulated by his example to do what she ought for the complete exploration of that part of Africa which forms, so to speak, the back garden of her West Coast colonies.

THE COMPARATIVE ANATOMY OF MAN[1]

I.

HUMAN anatomy, as ordinarily taught, has for its end simply the knowledge of the structure of the body of the man we have most to deal with in our practice, that is, the European man, in his usual average development. No cognisance is taken of the deviations from this ordinary but known type, except as individual variations, which have their principal interest in any interference they may cause with our diagnosis or treatment of the diseases or injuries to which our frame is liable.

The comparative anatomy of man goes beyond this. Instead of aiming at describing a general average man, by overlooking, or purposely eliminating, all deviations from the normal standard, it is specially occupied in studying the differences between one man and another, estimating and classifying these differences, and especially discriminating between such differences as are only individual variations (variations which, when extreme, are relegated to the department of the teratologist) and those that are inherited, and so become characters of distinct groups and races of the human species. Physical anthropology, moreover, extends its range beyond merely comparing and registering these differences of structure. It also occupies itself with endeavouring to trace their cause, and the circumstances which may occasion their modifications. It endeavours, also, to form a classification of the different groups of mankind, and so to throw

[1] Abstract of Prof. Flower's Hunterian Lectures, delivered at the Royal College of Surgeons, commencing on Wednesday, March 5.

light upon the history and development of the species. These are all exceedingly difficult and complicated problems.

As an example of one of the problems which the student of the Comparative Anatomy of Man sets himself, may be quoted the relation of the size of the brain to that of the rest of the body in different races and different individuals. An important contribution to this much-vexed question appeared in the last number of the French *Revue d'Anthropologie*, by M. Gustave Le Bon, in which the author, among other things, endeavoured to show that in lower races, and uncivilised conditions of the higher races, the brains of men and women were comparatively equal in size and weight, but that with elevation in the scale and advance of culture, the differences between the sexes increased, the women's brain remaining stationary, while that of the men augmented. There are, however, some fallacies in the statistics quoted in support of this proposition, which might apply to the women of France, although not to so great a degree as M. Le Bon seems to imply. The lecturer showed that in England, according to the best information yet obtained, the proportional size of the female brain to the male was as 9 to 10, very nearly the same as in the lowest and least cultivated of the races quoted by M. Le Bon.

As regards the relative size of the head in men, it seems probable from the investigations of Mr. Francis Galton and others, that on the whole men with the greatest amount of intellectual capacity have large heads, although this is by no means always the case. Small heads are frequently accompanied by great energy.

The Australians were described in last year's lectures, but as they are a very interesting race, being both socially and physically the most different from ourselves, it may be as well to go over some of their principal characters again.

Their habits are very primitive, their only domestic animal being the native dog, and their only weapons the boomerang, spear, and lance, having no bows and arrows. They have not acquired the art of pottery making. One of their principal characteristics is the small size of the brain-cavity compared with that of a European, the largest not coming up to the size of the average Italian peasant. Since last year five Australian skulls have been added to the museum, which are all extremely characteristic of the race. The average capacity of these five is 1,234 c.c., while the average of five ordinary European skulls is 1,574 c.c.

Another characteristic of the skull is that it is long and narrow; the cephalic index, or relation of the greatest breadth in the parietal region to the extreme length, which is taken as 100, being on the average 71 or 72. The super-orbital ridges are extremely pronounced, and the orbits are elongated, and short from above downwards. The nose is short and wide below, and the jaws project forwards. The skin of these people is dark, and their hair is black, but not curly.

The Tasmanians are in some respects allied to the Australians, and in others differ greatly from them.

Tasmania was discovered in 1642 by Abel Tasman, but it was not until 1777, when Capt. Cook visited it, that the intercourse between the English and the Tasmanians commenced. In 1803 it became an English colony. The race is now entirely extinct, the last man having died in 1869, and the last woman in 1876.

Unfortunately, but few skulls have been preserved, and we have very little information about this curious and interesting race. Their habits seem to have been very primitive; they had no domestic animals, not even the native dog, and no boomerang, their only weapons being a lance and a club or "waddy."

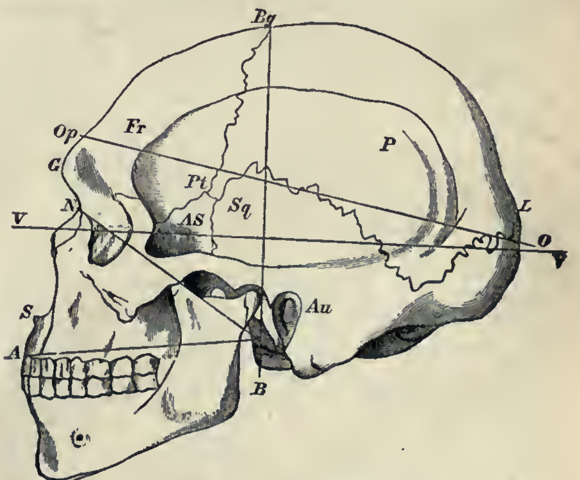
The skull is very characteristic, the parietal part being broader than in that of the Australians, and the hair is woolly, something like that of a negro, a microscopic section showing it to be flattened and elliptical, while straight hair is more or less cylindrical. They have probably been isolated from all other races for a great length of time, though it is likely that Australia was once inhabited by a people resembling them.

The islands of the Pacific Ocean proper are inhabited by two extremely distinct and different races, which are, however, often much intermixed. One of these, the Papuans or Melanesians, are very like negroes, having woolly hair, broad noses and mouths, and low orbits; the skull is long and narrow, and more like the Australian type. The other—the true Polynesian—of which the Samoans and Tongans may be taken as the best types, have more or less straight hair, and in many respects resemble the Malays; their heads are round, and they have a fine high face, with a long and narrow nose and a round short mouth. These latter are much more highly civilised than any of the races described above; when they were discovered, at the end of last century, they had houses, clothes, domestic animals, canoes, &c.

It seems very probable that these islands were once inhabited much more extensively by Melanesians, the Polynesians having colonised those which extend from the Sandwich Islands, on the north, to New Zealand, on the south, and having in most cases replaced the original race. Mixtures have also taken place, as in the Maories of New Zealand.

A few details must now be given about the methods of measuring the capacity of crania. This is a much more difficult operation than might at first sight be supposed. The best method seems to be that used by Mr. Busk, viz., filling the skull with rape or mustard seed, which is then measured with an instrument called a choremometer. It should always be filled to a maximum, a funnel of a certain aperture being used, and the seed being well shaken and pressed in, as a difference of three or four cubic inches may be made if these precautions are not attended to.

The capacity of a skull, as well as its extreme dimensions, varies much in proportion as it is wet or dry. One which measured 520 linear millimetres in circumference in summer increased 7 millimetres in winter.



Side view of skull of male Australian. *VV*, horizontal line, corresponding with visual axis; *A*, alveolar point; *S*, spinal point, or base of nasal spine; *N*, nasion, or centre of fronto-nasal suture; *G*, glabella; *Op*, ophryon, or centre of super-orbital line; *Bg*, bregma, or union of coronal and sagittal sutures: *L*, lambda, or union of lambdoid and sagittal sutures; *O*, occipital point; *Au*, auricular point, or centre of external auditory meatus; *B*, basion, or centre of anterior margin of foramen magnum; *Pt*, ptereon, or point where the frontal (*Fr*), parietal (*P*), squamosal (*Sq*), and alisphenoid (*AS*) bones meet.

The circumference of a skull is taken by passing a tape round it from a point called by Broca the *ophryon*, which

is the centre of a line taken just above the supra-orbital ridge or glabella, to the *occipital point*, or most prominent point of the occiput. The division commonly made between the anterior and posterior parts of the skull is by a line drawn from the middle of the external auditory meatus, or *auricular point*, to the *bregma*, or point where the coronal and sagittal sutures meet. The skull of a gorilla differs greatly from that of a European in the diminution of the portion situated behind this line, and the Australian cranium approaches the former where it differs from the latter, the posterior half being smaller than in the European.

The facial angle, or angle made by the profile with a horizontal line, is obtained by placing the skull in such a position that the axis of vision is horizontal. This is done by passing a rod exactly through the centre of the anterior opening of the orbit, and through the optic foramen. By means of a square, the amount of projection in front of or behind any given point can then be ascertained.

The three points forming what is known as the facial triangle are the *basion*, or centre of the anterior margin of the foramen magnum, the *nasion*, or centre of the fronto-nasal suture, and the *alveolar point*, or middle point of the upper jaw. The length is usually taken from the ophryon, but some take it from the glabella. The breadth is the greatest breadth in the parietal region.

Narrow skulls are called *dolichocephalic*, and broad ones *brachycephalic*. Taking the length as 100, if the index of breadth is above 80 the skull is brachycephalic; if below 75, dolichocephalic; while if it lies between these numbers it is called *mesocephalic*.

The height is taken from the basion to the bregma.

The form of the orbit varies much. The orbital index, or relation of the length (taken as 100) to the breadth, is very low in the Australians, the average being about 80. The form of the nose is characteristic both in races and individuals; the width compared with the height gives the nasal index. This varies much in individuals, but general averages are very important. The average nasal index of Australians is 57. Broca calls those races whose nasal index is lower than 48, *leptorhine;* between this and 53, *mesorhine;* and above 53, *platyrhine*.

The name *metopic* has been given by Broca to those skulls in which the suture between the frontals remains open in the adult. It generally closes up at the end of a year or two, and if it does not unite then, it rarely does afterwards. In European races this metopism is seen in about one cranium in ten, while in Australians and other low races it is extremely rare, as in monkeys.

The different races of men have been classified into two great groups according to the character of the hair, viz., the *Ulotrichi*, or woolly-haired people, and the *Leiotrichi*, or smooth-haired people. Mr. Charles Stewart has shown that, besides the difference in the microscopical structure of woolly and straight hair already mentioned, there is a difference in their mode of growth. The follicle in which an ordinary hair is developed is straight, while in the case of woolly hair it is curved, thus giving the hair a spiral twist. The woolly-haired people inhabit the greater part of Africa, and also a chain of islands extending from Tasmania to New Guinea and the Andaman Islands. These latter, or oceanic negroes, differ considerably from the former, or African negroes, and also differ very much among themselves. They may be divided into two distinct branches, an eastern and a western, and it is very difficult to determine whether they all arose from the same stock. In the eastern branch the people are nearly all characterised by high, narrow heads, much compressed at the sides, and features resembling the Australians.

The Museum of the College of Surgeons has lately received an interesting addition to the collection, viz., a dried man, painted red and otherwise ornamented, and fixed on a sort of hurdle, which was found in a hut on Darnley Island, in Torres Strait. The head of this man is less dolichocephalic than that of most Papuans, but it had probably been artificially compressed in infancy, many of these people having this peculiar custom. The mouth is large and projecting, but the nose is better formed than in the Australians.

When the Spaniards took the Philippine Islands they found them chiefly inhabited by Malays, but also in the wilder parts by a small race which they named Negritos. These have black complexions, woolly hair, and negro-like features. They perhaps extend as far north as to the south of Japan, but they are best marked in the Andaman Islands, where the race retains its purity.

The Andaman Islands consist of a long narrow chain of four principal islands, the Great Andamans, separated by narrow channels, as well as some smaller ones, called the Little Andamans. The first reliable notice of these islands is by some old Arab voyagers in the 9th century. No European traveller visited them until the end of last century. In 1788 a convict station was established at the south end, at a place which was called Cornwallis. This was soon abandoned, and another settlement made on the north. This, again, however, was given up, and it was not until November, 1857, that the Government once more took up the question and established a settlement on the site of Cornwallis, which is now called Fort Blair. For four or five years the natives were very shy, and the accounts of them are very unsatisfactory. They are now, however, becoming civilised, the English governors having built houses for them, and allowing them a certain quantity of food.

Although this chain of islands is only about 140 miles long, there are as many as nine distinct tribes speaking different languages. During the last year Mr. Man has sent over a valuable collection of their manufactures, and these show that in some respects they occupy a higher grade of civilisation than the Australians, Tasmanians, &c.

In the Little Andamans the people built beehive-like houses, but in the Great Andamans they had no permanent houses or clothes, the substitute for the latter being a thick coat of mud and pig's grease. A good deal of taste is shown in the manner in which this clothing is ornamented, one man being seen with half the body red and the other half yellowish, and ornamented by zigzag lines. A favourite ornament is a necklace made of the finger-bones of deceased relatives.

The Polynesians have a very general custom of preserving the bodies both of friends and enemies; the Borneans preserve their enemies, but the Andamanese give the preference to their friends. A widow often wears her husband's skull round her neck as an ornament.

The Andamanese do not cultivate the ground, but they are very expert with the bow and arrow. They cook their food, which consists principally of wild pigs and fish. They make canoes, hollowed out of the trunks of trees, and also a rough kind of pottery, simply moulded by the hand. There is no proof that they ever practised cannibalism, notwithstanding the frequency with which the charge has been brought against them.

There is much difference in the descriptions of travellers of the features and general characters of these people; some say that they are all very much alike, and others that they vary considerably both in form and features and character of hair, which is usually extremely black, close, and woolly. A section shows it to be nearly as flat as that of a South African Bushman. They, however, generally keep their heads shaved. All photographs hitherto sent to Europe show a very close general resemblance. The head is round, the forehead broad and upright, the nose small and straight, and the lips not very thick or projecting. They are a very small race, the average height being under five feet, the women being

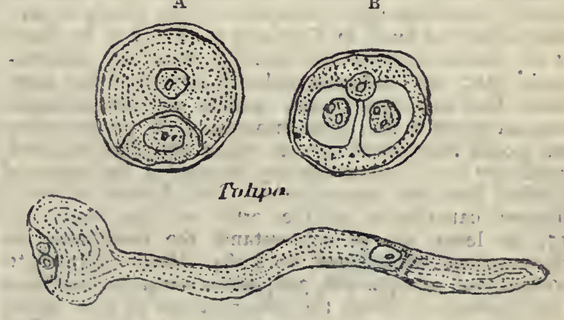
shorter than the men. There are, in fact, only three other races which are equal or approximate to them in smallness, viz., the Bushmen, the inhabitants of Tierra del Fuego, and the Lapps. The name of *Mincopie* has often been applied to these people, but it does not appear to be now used in the islands.

(*To be continued.*)

ON POLLEN PLANTS

THE evolution of the vegetable cell—using the word evolution as defined by Herbert Spencer—is a subject of immense interest that is now engaging the attention of some of the most scientific of the botanists. While the important researches of Carl Nägeli on cell-structure and cell-development can never be over-estimated, yet in these more recent times we are greatly indebted to the original and remarkable researches of Eduard Strasburger, which have thrown a flood of light on the subject, and opened out for it new and as yet untrodden by-paths. His thoughtful work, "Ueber Befruchtung und Zelltheilung," ought to be in the hands of every student. It is not here purposed to analyse the contents of this volume, now more than eighteen months on our shelves, but in it, we fear somewhat overlooked, we find the subject of the cellular-structure of the "pollen grains" in the angiosperms first mentioned, at least, in very recent times, and we are glad to perceive that the facts relating thereto have been recently restudied, and in some detail, by Fredr. Elfving, of Helsingfors, under the eye of Strasburger, and in his physiological laboratory at Jena.

We adopt for convenience the ordinarily received division of plants, in which the flowering plants, or those having the sex-cells developed in connection with phyllomes, are separated from the so-called flowerless plants, in which the sex-cells are formed on thallomes. All the more recent manuals of botany assert that the two groups of the former, the gymnosperms and the angiosperms, are differentiated, the one from the other, by certain striking peculiarities relating to their reproductive systems. One of these is that in the former the pollen-grains are multicellular, and that in the latter the pollen-grains are unicellular, a nice, and it ought to be an easily ascertained distinction, but unfortunately one that turns out on investigation not at all true. In the pollen-grains, or, as we would prefer to call them, the pollen-plants of the gymnosperms, there are all the essentials of an adult and independent form, that is to say, the protoplasmic contents of the pollen plant divide into two or more cells, of which one takes upon itself the growth and functions of the pollen tube, and the other remains with no such functional power, but at most plays the feebler part of a vegetative cell. There is thus, as it were, a thallus formed, one cell of which performs the function of an antheroidal or male cell. All this has been for some time known to be the case in the gymnosperms of which our cone-bearing trees and shrubs may serve as familiar types; but in the angiosperms, embracing nearly all our showy flowering herbs, shrubs, and trees, despite Strasburger's researches published in 1877, it is still most generally stated that inside the inner coat of the pollen-grain there is but a single protoplasmic mass which gives rise to the pollen tube. So far as this difference in the pollen goes, it will now probably not be again insisted on, for a glance at the very copious figures drawn from nature by Mr. Elfving will satisfy the most sceptical that the angiospermous pollen-grain is really a compound body, entitled to rank as a thallus, and in which, as in the gymnosperms, there are both functional and vegetative cells. The researches culminating in this memoir were chiefly made during the summer session of 1878 in the Botanical Institute at Jena. The pollen was cleared by means of a 1 per cent. solution of osmic acid, and then stained and preserved in a carmine-glycerine fluid. If the outer coat be not too dense, the contents can be seen through it after from one to two days' steeping in osmic acid. In order to see the growth of the pollen tube, recourse must be had to artificial culture; for this purpose many sorts of solutions were used, and these of very different degrees of condensation, but in the end the author came back to a simple solution of 1 to 25 per cent. of sugar. Some pollen plants required but weak solutions, others strong ones. The strength of the solution found in certain cases most useful is given in the details of the experiments. The culture upon most were generally made in the dark, and at a summer temperature, but some grown in daylight succeeded admirably. The orchids are referred to as affording most excellent subjects for these investigations. On three plates the different forms of pollen-plants to be met with in some twenty-three species of plants are represented. Of these we select that of *Tulipa gesneriana*, in which the vegetative cell happens to be very large (A in figure), and it very frequently divides, as seen at B, also that from *Butomus umbellatus* (C), showing the vegetative cell and the tube. In this figure the side walls are not represented. The chief results of these researches are collected together as follows:—The pollen-grain in the angiosperms becomes divided into two cells, generally a larger and a smaller one; the latter, the "vegetative" cell, by a further division, becomes developed into a two- or often a three-celled thallome. This vegetative cell, or these vegetative cells, are only separated from the larger cell by a wall of cortical plasm, (ectoplasm, Vines), but this, in particular instances, can become formed into a firmer membrane (cellulose?). The pollen tube is the result of an outgrowth of the larger cell.



In the gradual growth of this it may happen that the vegetative cell or cells will wander into the pollen tube, the wall of the larger cell having become obliterated, or they will remain free in the cavity of the mother-cell, often becoming spindle or half-moon-shaped.

The nuclei are often peculiarly fashioned, but with the exception of the Cyperaceæ no instance of a division of the nucleus of the larger cell was observed.

All the pollen plants described by Elfving belong to the sections either of the "wind-wafted" or the "insect-borne" forms. The study of the structure of the pollen plants of such cleistogamous flowers as those recently described by Bennett, such as some of the violets, wood sorrel, &c., may reveal some interesting facts. In them there would seem to be a greater individuality; the very behaviour of their pollen tubes is so different that they would appear as if they had a more independent basis; but this is rather a subject for research than for conjecture. In the meanwhile we may note how many apparently sure landmarks have been, in the botanist's country, lately thrown down by the researches of Warming, Strasburger, and now Elfving. It will be difficult by and by to invent neatly-

worded definitions to separate the sub-kingdoms, classes, and sub-classes of the vegetable kingdom. Modern research is now all destructive, nor seems it to have a thought as yet of proceeding on the lines of scientific construction.

E. PERCEVAL WRIGHT

OUR ASTRONOMICAL COLUMN

OLBERS' COMET OF 1815.—The Royal Society of Sciences of Haarlem have offered a prize for a new determination of the elements of this comet, founded upon the whole series of observations which remain in a form admitting of more accurate reduction than they have yet received, by the use of improved positions of the comparison stars and a calculation of the effect of perturbations, while the comet was visible, with the more precise values of the planetary masses which we now possess. Bessel, in his final memoir upon this comet, not only investigated the elements of the orbit from the *ensemble* of the observations in the form in which they were known to him in 1815, but essayed to determine the effect of planetary attraction upon the epoch of next return to perihelion, which he fixed to February 9, 1887, but he found that the period of revolution resulting from the observations in 1815, was liable to a probable error of ± 101 days. Unless the semi-axis major admits of determination within narrower limits, a recomputation of the perturbations would lose much of its value and interest, and accordingly the Haarlem Society, in stating the terms of the prize, limit the investigation now demanded to a definitive calculation of the orbit of the comet in 1815, at least we so understand the notification in *Astronomische Nachrichten*, No. 2,264. Allusion is made to NATURE, vol. xix. pp. 268, 366, where we gave references to publications in which the observations of this comet that admit of a new reduction are to be found. The Society at the same time offer a prize for a critical examination of Serpieri's theory of the zodiacal light, "especially if it is to be sought within or without the earth's atmosphere," and it does not clearly appear from the article in the *Astronomische Nachrichten*, whether one prize is intended to apply to the two subjects; we can hardly suppose that this is the case, as it seems unlikely that any one person would engage upon problems of so widely different a character.

THE NEW COMET.—The elements of the comet discovered by Mr. Lewis Swift do not bear resemblance to those of any comet previously computed, and it does not appear that the body is one of any special interest. The perihelion passage took place towards the end of April, and the comet is now slowly receding from the earth. From the direction of its path, so far as position is concerned, it might remain visible for a considerable time, but its brightness is stated to be sensibly diminishing.

THE COMET 1759 (III.).—The following orbit of this comet by Mr. Hind rests upon a new reduction of some of the observations made at Paris, and upon Cassini de Thury's last observation as given by Pingré.

Perihelion passage, 1759, Dec. 16·84108 G.M.T.

	° ′ ″	
Longitude of perihelion	138 28 35	Mean equinox 1760·0.
,, ascending node ...	79 50 4	
Inclination	4 52 31	
Log. perihelion distance	9·9848692	

Motion—retrograde.

This is the comet which became suddenly visible in Western Europe on January 8, 1760, when its distance from the earth was within 0·075 of the earth's mean distance from the sun.

VARIABLE STARS.—The following are Greenwich times of geocentric minima of Algol according to Prof. Schönfeld's elements, from the middle of July to the middle of October:—

	h. m.		h. m.		h. m.
July 15 ...	12 29·2	Aug. 27 ...	12 37·4	Sept. 22 ...	7 54·4
18 ...	9 17·8	30 ...	9 25·9	Oct. 6 ...	15 57·6
Aug. 4 ...	14 9·1	Sept. 16 ...	14 17·2	9 ...	12 46·2
7 ...	10 57·7	19 ...	11 5·8	12 ...	9 34·9
24 ...	15 48·9				

The rise in brightness of *Mira Ceti* to its maximum on September 11 may be well observed this summer. S Cancri will be at a minimum on September 18 at 10h. 4m. On the variations of the latter star Schönfeld's memoir published at Mannheim in 1872 may be advantageously consulted.

GEOGRAPHICAL NOTES

THE new number of the Geographical Society's periodical contains Mr. Keith Johnston's notes on "Native Routes in East Africa, from Dar-es-Salaam towards Lake Nyassa," accompanied by a very interesting map, in which are embodied the particulars gleaned by Mr. Johnston from native travellers. This paper is followed by Prof. Geikie's lecture on geographical evolution, of which an abstract appeared in NATURE, vol. xix. p. 490, and several pages are next devoted to a not very happy attempt to present the salient geographical features of Mr. Ryall's account of his explorations in Western Thibet, which forms one of the appendices of the *General Report* of the operations of the Survey of India for 1877-8. Among the geographical notes we find intimations that the science lectures are to be discontinued, and that the Council have arranged to provide means of instruction and training for intending travellers. There is also a note of Mr. M. C. Doughty's visit to El-Hejjer, a reported Troglodyte city in North-west Arabia, which disposes of singular fables that have been accepted by some learned Orientalists.

THE question of the availability of elephants in African exploration, lately so much discussed, is now about to be put to the crucial test of experiment. The four elephants presented by the Indian Government to the King of the Belgians for the use of his expedition have arrived safely at Zanzibar, and have been landed near Dar-es-Salaam, not, however, without some difficulty, as the following extract from a letter written by a lady who witnessed the scene will show:—"We never thought the first elephant could get alive to shore. It swam more than a mile in distance, and was in the water for more than an hour. Long after it was half way it would keep turning round and trying to come back to the ship. I cannot describe to you the excitement there was on board. I fairly cried once with anxiety and excitement, it would have been too horrible to see it drowned! It tried to climb up the ship's side once. It was pouring with rain, which made things seem more dismal; we were all wet through, but nobody cared. We had to get our experience as we went on, as no one knew anything about elephants on landing. We managed the other three much better, and made the Captain take the ship nearer in shore. Capt. Carter has stayed over there to take the elephants to Dar-es-Salaam, a distance of four miles, and will stay to see them comfortably settled."

THE *Novoye Vremya* gives some further news as to the progress of the Russian traveller, Col. Prjevalsky. The distance from the Saisan port to the River Buguluk, in the southern Altai mountains, was accomplished by the Colonel towards the end of April. All this tract is a barren desert, having neither flora nor fauna, though the banks of the River Urungu were found to bear some slight vestiges of vegetation. As for the climate, Col. Prjevalsky describes it as characterised by frost at night-time, with heat and storms during the day. Eight degrees of frost in the morning were often followed by 20 deg. of

heat at noon. Nevertheless, the scientific labours of the expedition had great success, the country being explored in all directions, and the gallant Colonel only hopes to attain as fruitful results in Thibet. He intended advancing to Barkul and Chami, as the shortest way through the southern Altai range.

FROM the Annual Report upon the Survey of the Northern and North-Western Lakes and the Mississippi River, in charge of Major C. B. Comstock and Capt. H. M. Adams, we learn that on Lake Erie the triangulation has been carried from Cleveland, Ohio, to the west end of the lake. The topography and hydrography have been extended to include all of the American shore, and the Canadian shore from Detroit River to Point Pelée. A base-line has been measured near Chicago and the connecting triangulation east has been completed to White Pigeon, Mich. The latitude and longitude of Memphis, Tenn., have been determined, and in connection with Capt. W. S. Stanton, United States Engineers, the longitudes of Fort Laramie, Wyo., Camp Robinson, Neb., and Deadwood, Dak., have been determined. The survey of the Mississippi River has been carried from Mound City, above Memphis, to Scanlon's Landing, Ark., and a line of precise levels has been completed from Memphis, Tenn., to Austin, Miss. A chart of Lake Ontario, coast charts Nos. 1 and 2 Lake Ontario, coast charts Nos. 7, 8, and 9 Lake Michigan, and detail charts Nos. 1, 2, 3, 4, 5, 6, and 7 Mississippi River have been completed.

IN his last report from Saigon, Mr. Consul Tremlett states that the water communication between Saigon, Cholon, and the western provinces of French Cochin China being very circuitous and inadequate to the traffic, the Canal of Cho-goo has been cut from Cho-goo to Soug-tra, being six miles in length and 110 feet broad. This canal is of immense importance to the country between the River Donnai and the Mei-Kong. Another short canal is to be cut near the junction of the Viaco and Soir-ap, two arms of the Donnai. Mr. Tremlett also mentions that a canal which did not attract much attention was opened in 1876, connecting the lower and upper branches of the Mei-Kong; it is 3½ miles long, and opens a more direct course from the south-western parts of the colony to Cholon, the great centre of traffic.

ERNEST MARNO, the well-known Austrian traveller in Africa, who originally formed one of the staff of the Belgian expedition under the late Capt. Crespel, has recently been appointed deputy governor of the province of Galabat in the Soudan. M. Statin, another Austrian traveller, has gone to the region of the Upper Nile, the special object of his journey being meteorological investigations.

MESSRS. S. T. LEIGH AND CO., of Sydney, have issued a map which will be very useful to persons visiting Australia during the approaching exhibition. It shows the Great Western Railway of New South Wales crossing the Blue Mountains, from the Nepean River to Bowenfells, also the localities and natural features of greatest general interest. The map has been compiled on the scale of one geographical mile to an inch by Mr. E. Du Faur, and is intended to accompany some fine photographs of the same region which Mr. Du Faur published about two years back. The more remarkable gorges and cliffs among the mountains are illustrated by dark shading.

NO. 1 of the new volume (36) of *Globus* has the first of a series of articles on the Island of Chios, by Dr. Ad. Testevuide, of that island. There are two papers of considerable ethnological interest: one by M. Andrée on the ethnological boundaries in France, and the other by Dr. Jung, mentioned in next note, on Australian types and sketches. Among the news are some details concerning Severtzov's second journey in the Pamir.

"AUSTRALIEN UND NEUSEELAND" is the title of an historical, geographical, and statistical sketch by Dr. Carl E. Jung, which has just been published at Leipzig (O. Mutze), with ten illustrations.

LAST YEAR'S SOLAR ECLIPSE[1]

WE have received an interesting account of the observations made during the late eclipse in Texas, under the direction of Mr. Waldo. The first part of the Report is chiefly taken up with an account of the determination of the geographical position of Fort Worth. The second part contains the reports of the various observers. Mr. Waldo gives a description of the photographs obtained. Unfortunately the camera had no proper clockwork. An ingenious, though most likely shaky, arrangement was used to correct the sun's motion in altitude, while his motion in azimuth was left to take care of itself. Each point more luminous than the remainder of the sun's corona is therefore drawn out into a line; but this outline of the moon's edge at the beginning and end of totality is sufficient to determine the position of these brighter points. An attempt was made to obtain photographic evidence of the polarisation of the corona, by inserting a double image prism between the lenses of the camera. The result was doubtful. The photographs were examined by Prof. Pickering, who found inequalities in them, which, as far as they go, tend to indicate a tangential polarisation; but in the opinion of Dr. Hastings, the evidence is not conclusive.

Mr. R. W. Willson observed the corona through a 3-inch telescope. By an oversight a red shade was not removed before totality. Through this shade the corona seemed to have a pretty well-defined limit about four or five minutes from the moon's limb. After the shade had been removed, other portions of the corona could be seen, the light of which was nearly as intense as that near the sun's limb; while the ring, which alone was visible through the shade, was not distinguished from the other parts of the corona. These observations would indicate that there is more red light in the corona near the body of the sun than away from it; and this observation is confirmed by Prof. S. H. Lockett, who, in a letter to Mr. Waldo, calls the outer corona "more bluish-white" than the inner corona.

Prof. J. H. Rees made some spectroscopic observations with a two-prism spectroscope. No bright lines were seen; but on widening the slit dark lines were noticed, amongst them especially C and D.

Mr. W. H. Pulsifer made also some spectroscopic observations. He noticed the reversal of the Fraunhofer lines with a tangential slit, and from the length of these lines he determined approximately the thickness of the reversing layer to be about 524 miles. No observations could be made during totality, as the image of the corona on the slit was lost, and could not be found again. The mischief was caused originally by one of the lamps, which went out just before totality. Moral: Don't trust to any lamps during eclipse observations. There is always a gust of wind at the beginning of totality, which is pretty sure to extinguish lamps.

Mr. Seagrave could see the inner corona about thirty seconds before totality.

Several gentlemen have sent in sketches of the corona, which are given on the last of the four plates accompanying the report. The remaining plates are taken up by an enlarged copy of the best photograph obtained, by a sketch illustrating Mr. Willson's report, and by a sketch of the corona made by Prof. Lockett.

ARTHUR SCHUSTER

[1] Report of the Observations of the Total Solar Eclipse, July 29, 1878, made at Fort Worth, Texas. Edited by L. Waldo. (Cambridge: J. Wilson and Son, 1879.)

MOLECULAR PHYSICS IN HIGH VACUA [1]

WHEN I was asked, a month or two ago, to illustrate in this theatre some of my recent researches on molecular physics in high vacua, I exclaimed, "How is it possible to bring such a subject worthily before a Royal Institution audience when none of the experiments can be seen more than three feet off?" If to-night I am fortunate enough to show all the experiments to those who are not far distant, and if I succeed in making most of them visible at the far end of the theatre, such a success will be entirely due to the great kindness of your late secretary, Mr. Spottiswoode, who has placed at my disposal his magnificent induction-coil—not only for this lecture, but for some weeks past in my own laboratory—thus enabling me to prepare apparatus and vacuum tubes on a scale so large as to relieve me of all anxiety so far as the experimental illustrations are concerned.

Before describing the special researches in molecular physics which I propose to illustrate this evening, it is necessary to give a brief outline of one small department of the modern theory of the constitution of gases. It is not easy to make clear the kinetic theory, but I will try to simplify it in this way:—Imagine that I have in a large box a swarm of bees, each bee independent of its fellow, flying about in all manner of directions and with very different velocities. The bees are so crowded that they can only fly a very short distance without coming into contact with one another or with the sides of the box. As they are constantly in collision, so they rebound from each other with altered velocities and in different directions, and when these collisions take place against the sides of the box pressure is produced. If I take some of the bees out of the box, the distance which each individual bee will be able to fly before it comes into contact with its neighbour will be greater than when the box was full of bees; and if I remove a great many of the bees I increase to a considerable extent the average distance that each can fly without a collision. This distance I will call the bee's *mean free path.* When the bees are numerous the mean free path is very short; when the bees are few the mean free path will be longer, the length being inversely proportional to the number of bees present. Let us now imagine a loose diaphragm to be introduced in the centre of the box, so as to divide the number of bees equally. The same number of bees being on each side, the impacts on the diaphragm will be equal; and the mean speed of the bees being the same, the pressure will be identical on each side of the diaphragm, and it will not move.

Let me now warm one side of this division so as to let it communicate extra energy to a bee when it touches it. As before, a bee will strike the diaphragm with its normal mean velocity, but will be driven back with extra velocity, the reaction producing an increase of pressure on the diaphragm. It will be found, however, that although the diaphragm is free to move, the extra strength of the recoil on the warm side does not produce any motion. This at first sight seems contrary to the law of action and reaction being equal. The explanation is not difficult to understand. The bees which fly away from the diaphragm have drawn energy from it, and therefore move quicker than those which are coming towards it; they beat back the crowd to a greater distance, and keep a greater number from striking the diaphragm. Near to the heated side of the diaphragm the density is less than the average, while beyond the free path the density is above the average, and this greater crowding extends to all other parts of the box. Thus it happens that the extra energy of the impacts against the warm side of the diaphragm is exactly compensated by the increased number of impacts on the cool side. In spite therefore of the increased activity communicated to a portion of the bees, the pressure on the two sides of the diaphragm will remain the same. This represents what occurs when the extent of the box containing the bees is so great, compared with the mean free path, that the abrupt change in the velocities of those bees which rebound from the walls of the box produces only an insensible influence on the motions of bees at so great a distance as the diaphragm.

I will next ask you to imagine that I am gradually removing bees from our box, still keeping the diaphragm warm on one side. The bees getting fewer the collisions will become less frequent, and the distance each bee can fly before striking its neighbour will get longer and longer, and the crowding in front of them will grow less and less. The compensation will also diminish, and the warmed side of the diaphragm will have a tendency to be beaten back. A point will at last be reached on the warm side, when the mean free path of the bees will be long enough to admit of their dashing right across from the diaphragm to the side of the box, without meeting more than a certain number of in-coming bees in their flight. In this case the bees will no longer fly quite in the same direction as before. They will now fly less sideways, and more forwards and backwards between the heated face of the diaphragm and the opposed wall of the box. Because of this preponderating motion, and also because they will thereby less effectually keep back bees crowding in from the sides, there will now be a greater proportionate pressure both on the hot face of the diaphragm and on that part of the box which is in front of it. Hence the pressure on the hot side will now exceed that on the cool side of the diaphragm, which will consequently have a backward movement communicated to it.

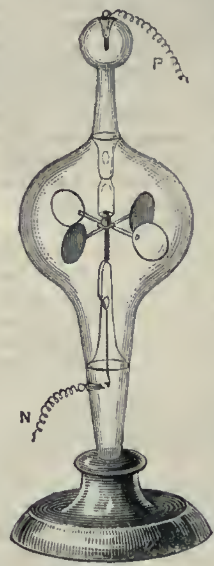


FIG. 1.

I may diminish the size of the bees as much as I like, and by correspondingly increasing their number the mean free path will remain the same. Instead of bees let me call them molecules, and instead of having a few hundreds or thousands in the box let me have millions and billions and trillions; and if we also diminish the mean free path to a considerable extent, we get a rough outline of the kinetic theory of gases. (I may just mention that the mean free path of the molecules in air, at the ordinary pressure, is the ten-thousandth of a millimetre.)

Three years ago I had the honour of bringing before you the results of some researches on the radiometer. Let me now take up the subject where I then left off. I have here two radiometers which have been rotating before you under the influence of a strong light shining upon them.

The explanation of the movement of the radiometer is this—the light, or the total bundle of rays included in the term "light," falling upon the blackened side of the vanes, becomes absorbed, and thereby raises the temperature of the black side: this causes extra excitement of the air molecules which come in contact with it, and pressure is produced, causing the fly of the radiometer to turn round.

I have long believed that a well-known appearance observed in vacuum tubes is closely related to the phenomena of the mean

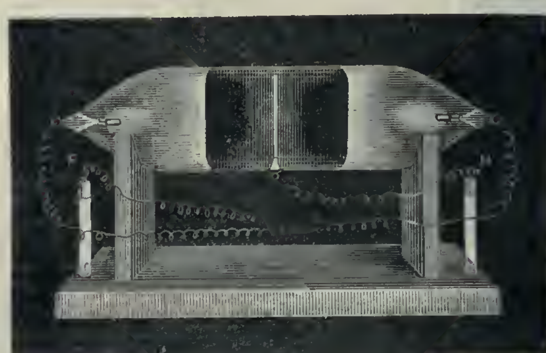


FIG. 2.

free path of the molecules. When the negative pole is examined while the discharge from an induction coil is passing through an exhausted tube, a dark space is seen to surround it. This dark space is found to increase and diminish as the vacuum is varied, in the same way that the ideal layer of molecular pressure in the radiometer increases and diminishes. As the one is perceived by the mind's eye to get greater, so the other is seen by the bodily eye to increase in size. If the vacuum is insufficient to permit the radiometer to turn, the passage of electricity shows

[1] A short-hand report of a lecture delivered at the Royal Institution on Friday, April 4, 1879. By William Crookes, F.R.S. Contributed by the author.

that the "dark space" has shrunk to small dimensions. It is a natural inference that the dark space is the mean free path of the molecules of the residual gas.

The radiometer which has just been turning under the influence of the lime-light is not of the ordinary kind. Fig. 1 will explain its construction.

It is similar to an ordinary radiometer with aluminium disks for vanes, each disk coated on one side with a film of mica. The fly is supported by a hard steel instead of glass cup, and the needle point on which it works is connected by means of a wire with a platinum terminal sealed into the glass. At the top of the radiometer bulb a second terminal is sealed in. The radiometer can therefore be connected with an induction-coil, the movable fly being made the negative pole.

As soon as the pressure is reduced to a few millims. of mercury, a halo of velvety violet light forms on the metallic side of the vanes, the mica side remaining dark. As the pressure diminishes, a dark space is seen to separate the violet halo from the metal. At a pressure of half a millim. this dark space extends to the glass, and positive rotation commences. On continuing the exhaustion the dark space further widens out and appears to flatten itself against the glass, when the rotation becomes very rapid.

You perceive a dark space behind each vane and moving round with it. In the first experiment, radiation from the lime-light falling on the metallic sides of the vanes, produced a layer of molecular pressure which drove the fly round; so here the induction-current has produced molecular excitement at the surface of the vanes forming the negative pole, extending up to the side of the glass.

When the negative pole is in rapid rotation it is not easy to see this dark space, so I have arranged a tube in which the dark space will be visible to all present. The tube, as you will see by the diagram (Fig. 2), has a pole in the centre in the form of a metal disk, and other poles at each end. The centre pole is made negative, and the two end poles connected together are made the positive terminal. The dark space will be in the centre. When the exhaustion is not very great the dark space extends only a little distance on each side of the negative pole in the centre. When the exhaustion is very good, as it is in the tube before you, and I turn on the coil, the dark space is seen to extend for about two inches on each side of the pole.

Here, then, we see the induction spark actually illuminating the lines of molecular pressure caused by the excitement of the negative pole. The thickness of this dark space—nearly two inches—is the measure of the mean free path between successive collisions of the molecules of the residual gas. The extra velocity with which the negatively electrified molecules rebound from the excited pole keeps back the more slowly moving molecules which are advancing towards that pole. The conflict occurs at the boundary of the dark space, where the luminous margin bears witness to the energy of the discharge.

I will endeavour to throw on the screen an illustration of this dark space. A stream of water falls from a small jet on to a horizontal plate of glass. The water spreads over the plate and forms a thin film. The jet of water in the centre, from the velocity of its fall, drives the film of water before it on all sides, raising it into a ring-shaped heap. As I diminish the force of the jet the ring contracts; this is equivalent to the exhaustion getting less. When I increase the force of water the ring expands in size, the effect being analogous to an increase of exhaustion in my tubes. The extra velocity of the falling particles of water drives the in-coming particles of water before them, and raises a ridge round the side which exactly represents the luminous halo to the dark space to be seen in this tube.

If, instead of a flat disk, a metal cup is used for the negative pole, the successive appearances on exhausting the tube are somewhat different. The velvety violet halo forms over each side of the cup. On increasing the exhaustion the dark space widens out, retaining almost exactly the shape of the cup. The bright margin of the dark space becomes concentrated at the concave side of the cup to a luminous focus, and widens out at the convex side. When the dark space is very much larger than the cup, its outline forms an irregular ellipsoid drawn in towards the focal point. Inside the luminous boundary a dark violet light can be seen converging to a focus, and, as the rays diverge on the other side of the focus, spreading beyond the margin of the dark space; the whole appearance being strikingly similar to the rays of the sun reflected from a concave mirror through a foggy atmosphere. This proves a somewhat important point; it shows that the molecules thrown off the excited negative pole leave it in a direction almost normal to the surface.

I can illustrate this property of the molecular rays by an experiment. This diagram (Fig. 3) is a representation of the tube which is before you. It contains, as a negative pole, a hemi-cylinder (*a*) of polished aluminium. This is connected with a fine copper wire, *b*, ending at the platinum terminal, *c*.

FIG. 3.

At the upper end of the tube is another terminal, *d*. The induction-coil is connected so that the hemi-cylinder is negative and the upper pole positive, and when exhausted to a sufficient extent, as is the case with this tube, the projection of the molecular rays to a focus is very beautifully shown. The rays are driven from the hemi-cylinder in a direction normal to its surface; they come to a focus and then diverge, tracing their path in brilliant green phosphorescence on the surface of the glass.

You will notice that the rays which project from the negative pole and cross in the centre have a bright green appearance; that colour is entirely due to the phosphorescence of the glass. At a very high exhaustion the phenomena noticed in ordinary vacuum tubes when the induction spark passes through them—an appearance of cloudy luminosity and of stratifications—disappears entirely. No cloud or fog whatever is seen in the body of the tube, and with such a vacuum as I am working with in these experiments—about a millionth part of an atmosphere—the inner surface of the glass glows with a rich green phosphorescence, the intensity of colour varying with the perfection of the vacuum. It scarcely begins to show much before the 800,000th of an atmosphere. At about a millionth of an atmosphere the phosphorescence is very strong, and after that it begins to diminish

FIG. 4.

until there are not enough molecules left to allow the spark to pass.[1]

I have here a tube which will serve to illustrate the dependence of the green phosphorescence of the glass on the degree of perfection of the vacuum (Fig. 4). The two poles are at *a* and

[1] 1·0 millionth of an atmosphere = 0·00076 millim.
1315·789 millionths of an atmosphere = 1·0 millim.
1,000,000 " " " = 760·0 millims.
" " " " = 1 atmosphere.

b, and at the end (*c*) is a small supplementary tube connected with the other by a narrow aperture, and containing solid caustic potash. The tube has been exhausted to a very high point, and the potash heated so as to drive off moisture and deteriorate the vacuum. Exhaustion has then been re-commenced, and the alternate heating and exhaustion have been repeated until the tube has been brought to the state in which it now appears before you. When the induction spark is first turned on nothing is visible—the vacuum is so high that the tube is non-conducting. I now warm the potash slightly, and liberate a trace of aqueous vapour. Instantly conduction commences, and the green phosphorescence flashes out along the length of the tube. I continue the heat, so as to drive off more gas from the potash. The green gets fainter, and now a wave of cloudy luminosity sweeps over the tube, and stratifications appear. These rapidly get narrower, until the spark passes along the tube in the form of a narrow purple line. I take the lamp away, and allow the potash to cool; as it cools, the aqueous vapour, which the heat had driven off, is re-absorbed. The purple line broadens out, and breaks up into fine stratifications; these get wider, and travel towards the potash tube. Now a wave of green light appears on the glass at the other end, sweeping on and driving the last pale stratification into the potash; and now the tube glows over its whole length with the green phosphorescence. Would time allow I might keep it before you, and show the green growing fainter and the vacuum becoming non-conducting; but time is required for the absorption of the last traces of vapour by the potash, and I must pass on to the next subject.

Fig. 5.

This green phosphorescence is a subject that has much occupied my thoughts, and I have striven to ascertain some of the laws governing its occurrence. I soon perceived that the phosphorescence was not in the body of the tube itself, but was entirely on the surface of the glass. Another peculiarity of the rays producing this green phosphorescence is that they will not turn a corner in the slightest degree. Here is a V-shaped tube (Fig. 5), a pole being at each extremity. The pole at the right side (*a*) being negative, you see that the whole of the right arm is flooded with green light, but at the bottom it stops sharply, and will not turn the corner to get into the left side. When I reverse the current, and make the left pole negative, the green changes to the left side, always following the negative pole, leaving the positive side with scarcely any luminosity.

In the ordinary phenomena exhibited by vacuum tubes—phenomena with which we are all familiar—it is customary, for the more striking illustration of their contrasts of colour, to have the tubes bent into very elaborate designs. The positive luminosity caused by the phosphorescence of the residual gas follows all the convolutions and designs into which skilful glass-blowers can manage to twist the glass. The negative pole being at one end and the positive pole at the other, the luminous phenomena seem to depend more on the positive than on the negative at an ordinary exhaustion such as has hitherto been used to get the best phenomena of vacuum tubes. I have here two bulbs (Fig. 6), alike in shape and position of poles, the only difference being that one is at an exhaustion equal to a few millimetres of mercury—such a moderate exhaustion as will give stratifications or the

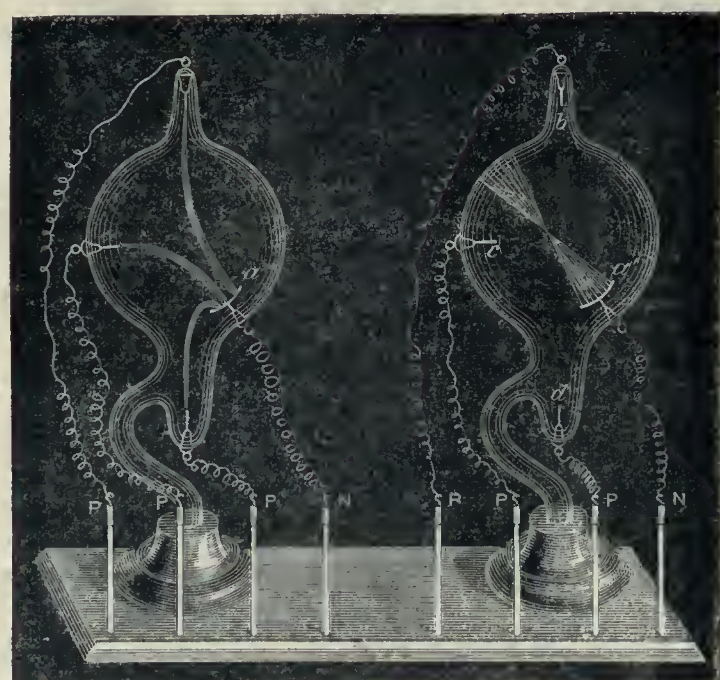


Fig. 6.

ordinary luminous phenomena—whilst the other is exhausted to about the millionth of an atmosphere. I will first connect the moderately exhausted bulb with the induction-coil, and, retaining the pole at one side (*a*) always negative, I will put the positive wire successively to the other three poles with which the bulb is furnished. You will see that as I change the position of the positive pole, the line of violet light joining the two poles changes. In this moderately exhausted bulb, therefore, the electric current always chooses the shortest path between the two poles, and moves about the bulb as I alter the position of the wires.

This, then, is the kind of phenomenon we get in ordinary exhaustions. I will now try the same experiment with a tube that is highly exhausted, and, as before, will make the side pole (*a'*) the negative, the top pole (*b*) being positive. Notice how widely different is the appearance from that shown by the last bulb. The negative pole is in the form of a shallow cup. The bundle of rays from the cup crosses in the centre of the bulb, and thence diverging, falls on the opposite side as a circular patch of green light. As I turn the bulb round you will all be able to see the faint blue focus and the green patch on the glass. Now observe, I remove the positive wire from the top, and connect it with the side pole (*c*). The green patch from the divergent negative focus is still there. I now make the lowest pole (*d*) positive, and the green patch still remains where it was at first, unchanged in position or intensity.

This, then, gives us another fact which brings us a little nearer to the cause of this green phosphorescence. It is this—that in the low vacuum the position of the positive pole is of every importance, whilst in a high vacuum it scarcely matters at all where the positive pole is; the phenomena seem to depend entirely on the negative pole. In very high vacua, such as we have been using, the phenomena follow altogether the negative pole. If the negative pole points in the direction of the positive, all very well, but if the negative pole is entirely in the opposite direction it does not matter; the line of rays is projected all the same in a straight line from the negative.

(*To be continued.*)

NOTES

THE following grants have just been made from the Research Fund of the Chemical Society:—30*l*. to Mr. W. Whitley Williams for experiments on an improved method of organic analysis; 25*l*. to Mr. M. M. Pattison Muir, of Caius College, Cambridge, for determining the physical constants and chemical habitudes of certain bismuth compounds; 15*l*. to Mr. J. M. Thomson for experiments on the action of isomorphous bodies in exciting the crystallisation of super-saturated solutions; 50*l*. to Dr. Wright for continuing his researches on chemical dynamics; 25*l*. to Mr. F. D. Brown for continuing his researches on the theory of fractional distillation; 30*l*. to Mr. Bolas for an investigation of certain chromium compounds; 20*l*. to Mr. F. R. Japp for an investigation of the action of organo-zinc compounds on quinones; and 100*l*. (the De la Rue donation) to Dr. H. E. Armstrong for the determination of certain physical properties, especially refractive indices, of typical chemical compounds. Dr. De la Rue has announced his intention of presenting the fund with another 100*l*. This will be the third donation of that amount which the fund has received from him.

THE Council of the Royal Society of Edinburgh have decided to award the Makdougall Brisbane Prize for the biennial period 1877–78 to Prof. Geikie for his "Memoir on the Old Red Sandstone of Western Europe," Part I., published in the Society's *Transactions*, and forming part of his valuable contributions to geology.

GENERAL MYER, of the U.S. Signal Corps, has arrived in Paris from Rome, on his way to London, where he will have an interview with the Meteorological Board for the purpose of establishing an understanding in matters of common interest, especially on the subject of exchanging telegrams with America, so that both nations may enjoy a daily summary of the weather on each continent.

M. LISSAJOUS has been elected a Foreign Corresponding Member in the Paris Academy, Section of Physics, in place of the late Dr. von Mayer.

DR. FAIVRE, the Dean of the Lyons Faculty of Sciences, has been run over by a cart when conducting a number of pupils to a botanical excursion. His constitution was so dreadfully shaken that he died after a few days of suffering. Dr. Faivre was opposed to the Darwinian theory, and has published books against the mutation of species. His most important publication was a review of Goethe's scientific works.

THE collection of living reptiles in the Jardin des Plantes, Paris, has just received an interesting addition in the shape of three living examples of the rare East-Indian serpent known to naturalists as *Acrochordus javanicus*. These snakes belong to quite a peculiar type of the Ophidian order, and are, in fact, truly fresh-water snakes, living among rocks wholly immersed beneath the surface, and but seldom rising up to inhale air. They are quite harmless, and allow themselves to be handled without difficulty. The food of the *Acrochordus* is supposed to be fruit—a most anomalous diet for a snake, if this is really the case, but the specimens at Paris have not yet shown a taste for eating anything.

WITH reference to a recent note, the Abbé Moigno writes us from Rome that he has not resigned the editorship of *Les Mondes*, which he has edited for twenty-seven years. He has gone to Rome to lay at the feet of the Pontiff the results of many years laborious work, but will return as he went, not a Cardinal, but the *doyen* of scientific journalists, eager for progress in all directions. We sincerely wish the Abbé many more years to carry on the work of editing his well-known journal, that has for so long done good service to science.

AMONG other recommendations made at the recent meeting of the International Meteorological Congress was the adoption of the meridian of Greenwich as the starting-point for the construction of synoptic weather charts. In the event of another meridian being used in the construction of meteorological charts the Congress recommended that the difference of longitude between the meridian employed and that of Greenwich should be stated on the chart.

A TERRIFIC thunderstorm broke over Paris on June 28 at six o'clock in the morning. There were a number of casualties; one of the most singular occurred in a room in the rue de Clichy, No. 34, where two old ladies live. One of them was drinking milk from a cup, which was knocked from her hands and could not be found, although the lady escaped unhurt. In the *rez-de chaussée* was the shop of a chemist, where a number of bottles were broken, and in the same house a bed, where a woman had taken refuge, was cut into two equal parts.

IN a balloon ascent which took place at Rouen on June 15 last with a large balloon, the occupants of the car found at 12,000 metres from the earth a cloud where the cold was so intense that small icicles were seen suspended to the beards and moustaches of the travellers.

THE Parkes Museum of Hygiene, founded as a memorial of the late Dr. E. A. Parkes to promote the study of all matters bearing upon the health of the community or the individual, was formally opened on Saturday by the Home Secretary, in the rooms on the top floor of the building lent by the council of University College until separate and suitable premises can be obtained. At present there have been brought together apparatus, specimens, books, reports, and drawings illustrative of matters connected with engineering and local hygiene; architecture, including general designs and details of buildings, methods of constructing hospitals, blocks of artisans' dwellings, &c., with

specimens of appliances for necessary sanitary arrangements, drainage, ventilation, and lighting; the furnishing of buildings, public and domestic, clothing, food; and the preservation of health and the relief of sickness. At present the collection is incomplete, but the committee hoped that funds and material would be forthcoming to make the Parkes Museum a national and a useful institution worthy of the important subject which it illustrated and the great name it bore. Prof. Huxley, who was present, expressed a hope that Mr. Cross would use his influence with the Government and with the House of Commons to stay a movement which appeared intended to dam back the stream of education and prevent the lower classes from gaining the knowledge they so much needed.

A MEETING of ladies and gentlemen interested in Japanese art, literature, folk-lore, &c., will be held to-morrow at the Royal Asiatic Society, 22, Albemarle Street. The meeting is called together for the purpose of establishing in London a central institution, with the following objects:—To bring into closer communication admirers and students of Japanese art, literature, &c.; and to collect, record, and disseminate information relative to Japan. To encourage residents in Japan, and the Japanese, to collect such material. To enlist the cordial co-operation of scientific and literary societies, and individuals, in extending the usefulness of the Institution. To publish proceedings, notes, queries, and other interesting matter; and to facilitate this branch of research and study. After the business is concluded, an "Old Resident" will communicate some interesting facts about Japan, illustrated by photos, &c., from his collection, and discussion will follow.

SOME attention has recently been drawn in the *Gardeners' Chronicle* to tea prepared in St. Michael, Azores, from plants grown in that island. It seems that two Chinese tea-growers have been sent for by the Agricultural Society of St. Michael, and after a careful examination of the tea-plantations they pronounced the plants as belonging to the very best varieties grown in China. It is prophesied that "the time is not far off when tea from St. Michael will come to the European market and prove to be of a very good quality." In a subsequent number of the *Gardeners' Chronicle*, however, Mr. Elwes points out the difficulties to be contended with in a competition with India and China in the production of tea, notably the price of land, the cost of labour, the temperature, extent of rainfall, &c. The first outcome of this tea growing in the Azores is shown in a sample recently received at the Kew Museum from Señor José de Canto. This sample is of good appearance through perhaps somewhat over roasted, the smell also is good, and the flavour of the infusion by no means to be despised.

THE new fodder grass *Euchlæna luxurians* known as the Teosinte, and which has attracted considerable attention of late, is reported from Ceylon as growing well, having been introduced from Java. The stems have attained in the former island the height of eight feet in three months from the time of sowing. The plant is stated to be unsuitable for cultivation at high elevations, but it is hoped that after a time it would become acclimatised to them. At the time the above was written the seeds were being distributed in several districts.

DR. SCHOMBURGK in his "Report on the Progress and Condition of the Botanic Garden and Government Plantations" of Adelaide, South Australia, for the year 1878, gives, as usual, a great deal of consideration to plants of economic interest. In the experimental ground many of the well-known British fodder grasses have been grown and produced satisfactory results. Dr. Schomburgk, however, points out the almost impossibility of stocking runs with artificial grasses on account of the large extent of pastoral land, and of the insuperable difficulty arising from climate and drought, to which some parts of the colony, especially the north, are often subjected. *Euchlæna luxurians* has not been introduced long enough to give any practical results. It is hoped, however, that the plant will turn out a great acquisition to the summer fodder plants of Australia. On the subject of flower farming for perfumery purposes there is no doubt that the Australian colonies offer special advantages for this branch of culture. Dr. Schomburgk thinks favourably of the scheme, but considers it unadvisable to manufacture the scents in the colony on account of the greater perfection with which this kind of work is done at home. As an illustration of the importance of this single use of flowers Dr. Schomburgk says:—If we consider that British India and Europe consume about 150,000 gallons of handkerchief perfume yearly, and the English revenue from Eau-de-Cologne alone is about 8,000*l*. a year; that the total revenue from imported perfumes is estimated at about 40,000*l*., and that one great perfume distillery at Cannes in France uses yearly about 100,000 lbs. of Acacia flowers (*Acacia farnesiana*), 140,000 lbs. of rose-flower leaves, 32,000 lbs. of jasmine blossoms, 20,000 lbs. of tuberose, together with a great many other sweet herbs, we may judge of the immense quantity of material used for perfume. It is satisfactory to find that the Colonial Parliament has granted a sum of 1,000*l*. towards the erection of a new building for the Museum of Economic Botany; this sum, however, it is expected, will be supplemented by a further vote, so that a building of sufficient size, to meet the requirements of the next generation, may be erected. The design, as already furnished, is for a building in the Romanesque style, 100 feet long by 36½ feet wide. The show cases will be fixed between the windows and at right angles with them on the plan adopted in the New Museum at South Kensington. From the promises of specimens, together with those already contained in the present museum, amounting to about 2,000 objects, it is expected that the museum when finished will form a very important adjunct to the gardens. The Report concludes with a notice of the *Phylloxera vastatrix*, or vine disease, which is enlarging its borders so much as to threaten a serious visitation in Australia.

SEVERAL remarkable results have been recently obtained by Herr Kohlrausch in his researches on the electric conductivity of aqueous solutions (*Annalen der Physik*), and especially with regard to the influence of temperature on the conducting power of liquids. Thus concentrated soda-lye, which, at a temperature of $-10°$ conducts badly, acquires, under action of heat, a conducting power which increases regularly and with very great rapidity, so that at $+80°$ the liquid conducts a *hundred* times better than at $-10°$. A solution of bisulphate of potash behaves quite differently; its conducting power increases very slowly with the temperature, up to a temperature of 60°, at which there is a maximum. From this point the conductivity remains nearly constant, as the temperature is raised. Studying solutions of sulphate of soda, which are known to present at 33° a remarkable peculiarity, due to the proportion, more or less, of water of crystallisation, Herr Kohlrausch found nothing peculiar in the conducting power. This seems to prove that water of crystallisation does not play any part in the conductivity of liquids for electricity.

IN addition to his astronomical paper, Admiral Mouchez is preparing the organisation, at the Observatory, of a High School of Astronomy composed of pupils from the Polytechnic and Normal Schools, and licenciés en sciences, mathematiques, et physiques. The salary of successful pupils will be 1,800 francs a year, and positions will be secured for them in the French national observatories. The school will also admit a number of free students, who will have the advantage of the use of the instruments of the observatory.

THE New York correspondent of the *Daily News* telegraphs as follows:—"Mr. Edison has obtained a dynamometer of suffi-

cient delicacy to measure every one-hundredth of horse-power. With this instrument he can calculate the cost of the electric light to the minutest detail. He has demonstrated that from 80 to 90 per cent. of energy is converted into light, and that six electric lights are supplied from one horse-power at one-third the cost of gas. He maintains that the problem of applying the electric light to domestic use has been practically solved, but admits that a great mass of detail remains to be worked out. He has satisfied himself that platinum can be supplied in large quantities so as to reduce the expense.

THE forests of Central Nevada appear (from the accounts of Mr. Sargent, who visited the region last year, and writes about them in *Silliman's Journal* for June) to be miserably poor in extent, productiveness, and especially in number of species. Yet they are of immense value, as regulating and protecting the rare and uncertain streams on which the agriculture of Nevada depends, and furnishing a large population with fuel and lumber, a population practically cut off from outside supply. Mr. Sargent laments the wasteful destruction of forest which follows every new discovery of the precious metals in that region, both on account of the immense age of these forests, and of the impossibility of restoration; and he thinks government should check it. The central Nevada forests consist of but seven species, the juniper (*Juniperus californica*, var. Utahensis) and nut pine (*Pinus monophylla*, Torr.), being the most common. Mountain mahogany (*Cercocarpus ledifolius*) comes next, probably the only North American wood heavier than water, and furnishing the common and cheapest fuel. The other species are the red cedar, the aspen, and two of pine. A comparison which Mr. Sargent makes, of the arborescent vegetation of Nevada with that of the region lying directly east and west of the Great Basin, brings out still more clearly the remarkable poverty of the former.

A VERY ingenious application of electricity to the purposes of navigation has recently been effected by Mr. Henry A. Severn, of Herne Hill, who has succeeded in producing a mariner's compass which enables the captain or officer in charge to hear, by the ringing of a bell, when the vessel is out of the ordered course. The whole of the apparatus is contained in a small box which is easily carried about, and is intended, as a rule, to be placed in the captain's cabin. Over the card are two index hands, which can be adjusted to any angle allowing of greater or less deviation in steering to either the port or starboard side. Assuming the captain, on quitting the deck, to have given instructions to steer the ship on a certain course, he sets the index hands to a certain angle, allowing the steersman a given latitude for deviation either to port or starboard of that course. Should the ship be steered off her course beyond the limit allowed on either side an electric alarm-bell rings instantaneously and, moreover, continues ringing until the right course is resumed. The metal point on which the card is hung is insulated from the compass bowl, and to it is attached a wire from one pole of a small battery. About an inch above the card, placed parallel to its surface and attached to its metal centre (which is insulated from the needle) is an arm of metal reaching nearly to the edge of the card. This arm is, therefore, in metallic communication with the wire from the battery already referred to. The glass lid of the compass has a short brass rod working within a tube passing through it. These are severally attached to two brass milled heads above the glass lid and to the two movable index-hands beneath the glass. These are in metallic contact with the brass-work of the compass, and this with the other pole of the battery. Beneath the outer extremities of the index-hands are suspended two pieces of platinum wire about three-quarters of an inch long. These hands can, by means of the two milled heads, be moved round to any position over any point of the card. Hence they admit of being placed on either side and equally distant or otherwise from the end of the metal arm on the card. It will thus be seen that whenever the platinum wires come into contact with the metal arm on the card the circuit is completed. The electric bell being placed in the circuit sounds whenever such contact takes place. Two bells of different tone can be used, and thus the instrument will indicate to the captain whether the deviation in steering is to port or starboard.

WE have received an interesting *Jahresbericht* of the Natural History Society of Wisconsin, which is evidently largely composed of Germans, the Report being in that language.

WE have on our table the following books:—"The Human Species," A. de Quatrefages (C. Kegan Paul); "Practical Photography," Part 1, O. E. Wheeler (*Bazaar* Office); "Modern Meteorology" (Ed. Stanford); "Mechanics," Prof. R. S. Ball (Longmans); "The Application of Generalised Co-ordinates to the Kinetics of a Material System," H. W. Watson and S. H. Burbury (Clarendon Press); "Galileo Galilei," Karl von Gebler (Kegan Paul); "What is Truth," John Coutts (F. Pitmann); "Sulphuric Acid and Alkali," Vol. i., George Lunge (Van Voorst); "Elementary Arithmetic and How to Teach It," G. Ricks (Isbister and Co.); "Supplement to a Handbook of Chemical Manipulation," C. G. Williams (Van Voorst); "Town and Window Gardening," C. M. Buckton (Longmans); "Der Process Galilei's und die Jesuiten," Dr. F. H. Reusch (Edw. Weber, Bonn); "Parasites, a Treatise on the Entozoa of Man and Animals," T. Spencer Cobbold, M.D. (Churchill); "Elements of South-Indian Palæography," A. C. Burnett (Trübner); "Twenty Lessons in Inorganic Chemistry," W. G. Valentine (W. Collins); "Observed Lunar Distances," John B. Pearson (Bell and Sons); "Floral Dissections," Rev. G. Henslow (Edw. Stanford); "Contributions to our Knowledge of the Arctic Regions," Part 1 (Edw. Stanford); "Proceedings of the Aberdeenshire Agricultural Association," Sessions 1878; "A Manual of Scientific Terms," Rev. James Stormouth (Maclachlan and Stewart, Edinburgh); "Hand List of Mollusca in the Indian Museum," Part 1, Godfrey Nevill (Calcutta); "Chronological History of Plants" Charles Pickering (Trübner); "Report of New York State Survey, 1878," James F. Gardner; "Pontresina and its Neighbourhood," J. M. Ludwig (Stanford); "Description physique de la République Argentine," Vols. ii. and v., and Atlas, &c., Dr. H. Burmeister (Paris, F. Savy); "British Birds," G. Peter Moore (J. van Voorst); "A Hunting Expedition to the Transvaal," D. Fernandes das Nives (Bell); "Origin of the Laws of Nature," Sir Edw. Beckett, Bart. (S.P.C.K.); "Lectures on Practical Astronomy," Rev. J. Challis (Deighton, Bell, and Co.); "Arithmetic," J. W. Marshall (Marcus Ward); "Scientific Lectures," Sir John Lubbock (Macmillan and Co.); "Agricultural Botany, Turnip-singling," A. Stephen Wilson (Smith, Aberdeen); "The Rights of an Animal," E. B. Nicholson (Kegan Paul); "Commercial Organic Analysis," Vol. i., Alf. Allan (Churchill); "Demonology and Devil-Lore," 2 vols., M. D. Conway (Chatto and Windus); "Atlas of Histology," Part 5, Smith and Klein (Smith, Elder).

THE additions to the Zoological Society's Gardens during the past week include a Crested Pigeon (*Ocyphaps lophotes*) from Australia, presented by the Rev. A. H. Glennie; two Lesser Redpoles (*Linota linaria*), British, presented by Dr. Bree, F.Z.S.; a Common Lobster (*Homarus vulgaris*), British Seas, presented by Mr. G. H. Jones, F.Z.S.; two Black-tailed Godwits (*Limosa melanura*), British, two Beautiful Parrakeets (*Psephotus pulcherrimus*) from Australia, four White Storks (*Ciconia alba*), European, two Tuatera Lizards (*Sphenodon punctatus*) from New Zealand, purchased; two Geoffroy's Doves (*Peristera geoffroii*), three Spotted-billed Ducks (*Anas pœcilorhyncha*), three Australian Wild Ducks (*Anas superciliosa*), three Chilian Pintails (*Dafila spinicauda*), bred in the Gardens.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

MR. AND MRS. HENRY SIDGWICK contribute each 500*l*. to the building fund (11,000*l*. being required) for the new hall to be built at Newnham, Cambridge, for women students, under the "Newnham College Association" for the advancement of education and learning among women in Cambridge. Miss Clough, the principal of Newnham Hall, whose unpaid services are of incalculable value, also gives 500*l*. to this new building, which will include lecture-rooms, &c., as well as residence for thirty. Prof. and Mrs. J. C. Adams, Dr. and Mrs. Bateson, Mr. and Mrs. Peile, &c., are among the large donors, and the Rev. Coutts Trotter, of Trinity College, is a donor of 100*l*.

THE Chemical Laboratory of Newnham Hall, which has cost over 1,000*l*., is now complete, and will be available for all the students of the Newnham Association. So also will be the Gymnasium and Garden. The Old Newnham Hall company is now merged in the new association, differing from the former in the contributors not being permitted to receive any profits. It is needless to add that the old association did not actually receive any profits, though registered as an ordinary "limited" liability company.

THE main purpose of the Irish University Bill, introduced to the House of Lords on Monday by Government, seems to be the creation of an institution similar to that of London University, prepared to grant degrees to all comers. In order to do this Government propose to establish a new University, to consist of a Chancellor and Senate to be appointed by the Crown, and not to exceed thirty-six in number. But though nominated in the first instance by the Crown, arrangements would be made to fill up a certain number of the vacancies afterwards, so that Convocation might have the election of six members of the Senate. The Government proposed, with regard to the Convocation, that it should consist of the graduates who had obtained their degrees in this University, or any one who might be transferred to or become graduates from the other University. The Government proposed that the Senate should elect the Vice-Chancellor, and also that the new University thus constituted should appoint examiners and conduct examinations for matriculation and degrees, and that it should confer degrees in all faculties except theology. They proposed that those degrees should be granted without regard to residence in any particular college, that the examinations for those degrees should be with regard to the standard of efficiency only, and that the degrees should be conferred on all who came up to the standard, and they proposed that there should not be any professors or lecturers connected with the University, thus following the example of the University of London. The Government are of opinion that steps should be taken for the dissolution of Queen's University, and that graduates of Queen's should become graduates of the new University, and those who were matriculated students of one should be so of the other, and possess all the same privileges and advantages in the new University as they did in Queen's.

FIVE years ago, when the late Lord Lawrence publicly presented the first Mortimer Scholarship Prize, Prof. Huxley made a speech which has proved prophetic. It was to the effect that the ladder of Board School education planted in the gutter might land such lads as Baker in the highest universities. That lad enjoyed his Mortimer Scholarship (worth 30*l*.) one year. He then obtained a scholarship in the City of London School. In four years more he obtains an open scholarship in Trinity College, Cambridge, at seventeen years of age. An immediate result of this success of the Elementary Education Act is that the Brewers' Company have since presented two scholarships to the London School Board.

IT was stated in Parliament on Monday that a petition having been presented to the Queen in Council, praying Her Majesty to grant a charter for a new Northern University, to be called the Victoria University, Her Majesty had been advised to grant the petition.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 5.—From experiments here described, on magnetisation of steel during the hardening process, Herr Holtz concludes that the method offers no advantages in practice. Magnets can, indeed, be thus made six times as strong as by the ordinary method, but this holds good only for extremely weak magnetising force; as you increase the force the difference rapidly decreases, and ere long becomes in favour of the ordinary method.—Herr Schellbach and Herr Boehn describe some instructive effects got on plates covered with carbon-dust placed under a discharger of a Leyden jar. Various devices were introduced for reflection, &c., of the sound-waves, whose mechanical action is indicated by the resultant figures on the plates.—Herr Wroblewski finds that a tenfold increase of the viscosity of water (by dissolving a crystalloid or colloid in it) produces only a five or six-fold diminution of the value of the constant for diffusion of carbonic acid in pure water.—The lowering of tone undergone by a sounded tuning-fork when immersed in liquids having been attributed by Herr Auerbach to the circumstance that kinetic energy is dispersed in incompressible liquids in another way than in gases (the changes of state in liquids being supposed to occur isothermally, in gases isentropically), Herr Kolacek offers another explanation based on mechanical principles.—In an inaugural dissertation Herr Freund writes on some galvanic properties of aqueous metal-salt solutions, his experiments having been made by Paalzow's method; and the results for sulphate of copper solution differing about 5 per cent. from those formerly obtained by Herr Beetz, he offers an explanation of this; which, however, Herr Beetz rejects, adhering to his own numbers.—Herr Ketteler contributes a paper on the theory of double refraction, and Herr Rammelsberg writes on some topics in mineralogical chemistry.

Morphologisches Jahrbuch, vol. 5, part 1.—This number contains no fewer than thirteen lithographic plates. Three of these illustrate Oscar Hertwig's second part of his memoir on the piscine dermal skeleton. He deals now with the ganoids (Lepidosteus and Polypterus).—R. S. Bergh, on the early development of the ovum of *Gonothyræa loveni* (Allman), 2 plates, 40 pages.—G. Born, the nasal cavities and passages of the amniotic vertebrata (3 plates, and about 80 pages).—O. Kling on *Craterolophus tethys*, a contribution to the anatomy and histology of the Lucernaridæ (3 plates, 26 pages).—A. Rauber, on the occurrence of budding among the vertebrata (2 plates).

Zeitschrift für wissenschaftliche Zoologie, vol. 32, part 2.—J. E. Boas, the teeth of the Saroids (25 pages).—R. Wiedersheim, the anatomy of *Amblystoma weismanni*, with two large coloured plates.—R. Greef, the pelagic annelids of the Canary Islands (45 pages, 3 plates); with discussions on the comparative anatomy of the Tomopteridæ, and figures and descriptions of Pontodora, &c., and several new species of Tomopteris.—H. Simroth, on the locomotion of Limax; two plates figuring *L. cinereoniger*.—J. Ciamician, on the histology and embryology of *Tubularia mesembryanthemum* (25 pages, 2 plates).

Kosmos, vol. 3, part 1, April, 1879.—The first article, "Natural Science in the Middle Ages," by Fritz Schultze, refers especially to Roger Bacon.—The controversy about *Planorbis multiformis* (1st art.), by F. Hilgendorf, is, among other figures, illustrated by a series of outlines of the different varieties of *P. multiformis*, as seen in section, &c., and referring to Sandberger's views.—Hermann Müller contributes an article of 16 pages, on Samuel Butler's "Life and Habit."

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. xii. fasc. x.—We note here the following:—Researches on the electric conductivity of carbon (continued), by Prof. Ferrini.—On a surface of capillarity, by Dr. Poloni.—Influence of climate and soil on the combustibility of tobaccos, by S. Cantoni.

Journal de Physique, June.—Spectroscope for observation of ultra-violet radiations, by M. Cornu.—Spectrometric measurement of high temperatures, by M. Crova.—Magnetic rotatory power of gases, by M. H. Becquerel.—Magnetic rotatory power of liquids and their vapours, by M. Bichat.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 19.—"Researches in Chemical Equivalence. Part III.—Nickelous and Cobaltous Sulphates." By Edmund J. Mills, D.Sc., F.R.S., and J. J. Smith.

Although the chemistry of nickel and cobalt is interesting from many points of view, it is more especially attractive from the probable isomerism of these metals. Their combining proportions, in fact, according to the most valuable evidence we possess, appear to be entirely the same. The authors, therefore,

thought it very advisable to inquire on what terms these metals might prove to be mutually equivalent: and the particular equivalence they have examined has been equivalent precipitability of the sulphates, by sodic hydrate, from an aqueous solution.

After describing the mode of preparation of the pure sulphates, the authors give an experimental criticism of the methods of separating nickel from cobalt, finally adopting the one devised by Gibbs. Having then fixed on the method of separation, 1 per cent. solutions of nickelous and cobaltous sulphates were prepared, and a solution of sodic hydrate, of which 10 cub. centims. were capable of precipitating ·8248 grm. of nickelous or cobaltous sulphate. This sodic hydrate was made from sodium, and kept in glass bottles coated internally with a thick layer of paraffin.

A series of nine experiments was made, in which the relative weights of nickelous or cobaltous sulphate present, varied from ·1 to ·9 grm.; the total weight of nickelous and cobaltous salt, and the volume of the solution being, however, always the same, viz., 1 grm. and 100 cub. centims. The experiments were conducted as follows:—The bottles containing the solutions of the sulphates and the sodic hydrate were immersed in a trough into which there was a constant flow of water to bring them to a constant temperature. The necessary quantities of nickelous and cobaltous solutions were then carefully measured out, mixed, and the temperature observed. 10 cub. centims. of sodic hydrate was then added, the solution stirred vigorously, and the temperature again observed. The precipitate was then filtered off as quickly as possible (an aspirator being used to facilitate the filtration), and washed, first with cold and then with hot water. It contained sodic sulphate, cobaltous sulphate and hydrate, and nickelous hydrate, all of which were analytically determined.

If n represent a weight of nickelous sulphate taken, and ν be the hydrate (calculated to sulphate) obtained from it through precipitation, the experiments show that $n = (1 + \cdot 21940\, n)\, \nu$. Similarly, for cobalt, $c = 1 \cdot 1845 y$. The authors give the following conclusions as the result of a discussion of their work:—(1) *The precipitability of nickelous sulphate is directly proportional to its mass*; (2) *The precipitability of cobaltous sulphate is an invariable quantity*; (3) *For an equal weight nickelous and cobaltous sulphates are equally precipitable; the attraction of the one towards the reagent being then inverse to that of the other.*

They accordingly write $\phi\,(NiSO_4) = (\phi\, CoSo_4)^{-1}$.

"On the Formation of Hydrocyanic Acid in the Electric Arc." By James Dewar, M.A., F.R.S., Professor of Chemistry to the Royal Institution.

The inference drawn from experiments given in the paper is that the reaction is in all probability the result of acetylene reacting with free nitrogen, as when induction sparks are passed through the mixed gases, viz.—

$$C_2H_2 + N_2 = 2HCN,$$

and that the hydrogen is obtained from the decomposition of aqueous vapour, and the combined hydrogen in the carbons. It is possible, traces of alkaline salts in the carbon poles may favour the formation of hydrocyanic acid, but, as all attempts to purify the poles so as to stop the reaction failed, I am inclined to believe it is a direct synthesis. The acetylene reaction is one of the many remarkable syntheses discovered by Prof. Berthelot of Paris. The presence of sulphuretted hydrogen is doubtless due to the reduction of the sulphates, invariably present in the ash of the carbon.

"An Account of Experiments on the Influence of Colloids upon Crystalline Form, and on Movements observed in Mixtures of Colloids with Crystalloids." By William M. Ord, M.D. Lond., F.L.S. Communicated by J. Simon, C.B., D.C.L., F.R.S.

Chemical Society, June 19.—Dr. Roscoe in the chair.—The following papers were read:—On Gardenin, by Dr. Stenhouse and Mr. C. E. Groves. This substance has been extracted from "Dekamali gum," the resin of the *Gardenia lucida*. Gardenin by treatment with nitric acid is converted into a mass of red crystals of gardenic acid; an acetyl derivative has been obtained. Gardenic acid in contact with sulphurous acid is converted into hydrogardenic acid.—On dry copper-zinc couples and analogous agents, by Dr. J. H. Gladstone and Mr. A. Tribe. By heating nine parts of coarse zinc filings with one part of finely divided copper in a flask over a Bunsen flame until the filings begin to lose their shape, dark grey granular masses are obtained. These masses constitute the dry copper-zinc couple, which is found to equal in activity the well-known moist copper-zinc couple, prepared by immersing zinc foil in copper sulphate solution; ten grammes of the dry couple convert 5 cc. of ethyl-iodide into zinc ethiodide in about six minutes. Couples of other metals were tried, but none were found to be in practice superior to that formed of copper and zinc.—On the action of sulphuric acid on the hydrocarbons of the formula $C_{10}H_{16}$, by Drs. Armstrong and Tilden. The authors deny the statement made by Ribau that the product of the above action yields a distillate when steam is passed through it consisting of cymene with a liquid isomeride of terpene; the so-called terebene is really inactive camphene, melting at 47°. The crude colophene remaining after the distillation in steam yields on distillation 10–30 per cent. of volatile substances—inactive camphene, terpilene, a paraffin-like body, an optically inactive camphor, &c. — Researches on the terpenes, camphor, and allied compounds, by Dr. Armstrong. Part I. On hydrocarbons associated with the terpenes, and on the formation of cymene from terpenes and allied compounds. II. On the action of iodine on terpenes. III. Camphor derivatives. —Contributions to the history of starch and its transformations, by Messrs. H. F. Brown and Heron. The authors have examined in a most elaborate manner the action of malt extract at various temperatures and under varied conditions, on potato starch. — On the determination of nitric acid by means of indigo, with especial reference to water analysis, by Mr. R. Warington. The author gives the results of much experience with this process, which has the advantages of great simplicity, speed, and delicacy; the results are, however, conditioned by many circumstances which must be known before the method can be applied with delicacy.—Notes on the purple of the ancients, by Dr. E. Schunck. The author has worked up about 400 specimens of *Purpura lapillus*, a shell-fish found at Hastings, and extracted the cyst containing the yellowish secretion which in sunlight becomes purple and forms a permanent dye stuff. The colouring matter apparently belongs to an unknown member of the indigo-blue group.—On the heat of formation of aniline, picoline, toluidine, lutidine, pyridine, dipicoline, pyrrol, glycerine, furfurol, by W. Ramsay.—On ethylenic chlorosulphocyanide and its oxidation into ethylenic chlorosulphonic acid, by J. W. James.—On mixing and heating potassium sulphocyanide with alcohol and chlorobromide of ethylene, potassium bromide, and chlorosulphocyanide of ethylene were obtained. The latter with nitric acid gave chlorocthylene sulphonic acid, the silver salt of which heated with ammonia furnished taurin.—On the boiling points of certain metals and metallic salts, by Dr. T. Carnelly and Dr. W. Carleton Williams.

Linnean Society, June 19.—Prof. Allman, F.R.S., president, in the chair.—Attention was called to two volumes folio on the British fresh water fishes by the Rev. W. Houghton. These, recently issued, illustrate in colours all the known and new species.—The Secretary read a paper on a remarkable branched *Syllis* from the *Challenger* expedition, by Dr. W. C. McIntosh. This Polychæte worm *S. ramosa* was got in the basal canals of a hexactinellid sponge, dredged near Zebu, Philippines. Thread-like in thickness, the branches are intricately arranged among the meshes of the sponge, and it appears that but one head must serve for many branches. Buds and secondary buds are very numerous on the latter, and in a free female pedal bristle-tufts were observed. A fragment of a different form is suggested, as possibly the male of the foregoing rare example of a truly branched annelid, differing in most particulars from anything heretofore recorded.—There followed remarks on *Carpesium* (*C. cernuum*) as indigenous to Australia, by F. M. Bailey. The author supports Mr. Bernay's view of this plant not being introduced, but undoubtedly endemic.—Mr. A. Hammond read a paper on the thorax of the blowfly. Most authorities at present recognise the great preponderance of the mesothorax over the other two segments, but do not fix the limits of each. The author refers to the integumentary parts entering into the thorax of insects, as enumerated by Audouin, and also especially to the views held by Westwood, Burmeister, Lowne, and others. Afterwards he gives a full description of his own dissections and preparations, and reasons for dissent from the majority of workers, though with evident inclination to Audouin's opinions. He concludes that, from the analogy presented by other insects, from the evidence derivable from the phenomena of developmental change, and from a study and consideration of the nervous and muscular systems all combine to show that the thorax of the Diptera, as illustrated in the blowfly, is almost exclusively mesothoracic, a conviction quite at

variance with that promulgated by Lowne in his researches on the blowfly.—The Rev. J. M. Crombie gave an enumeration of the lichens in the herbarium of the late Rob. Brown in the British Museum. These were collected 1802-5 during the notable voyage of Capt. Flinders to New Holland and Tasmania. No complete catalogue of these lichens was published by Brown, though many bear his MS. names, and only the more common species were indicated in the Appendix to the above voyage. A paucity of "saxicole" species in this as in more recent collections of exotic lichens is to be regretted.—Mr. G. Busk read a paper on recent species of Heteropora, founded chiefly on material got in the *Challenger* Expedition. Hitherto material for a knowledge of these has been among fossil forms, but quite lately Mr. Waters has drawn attention to a recent example in the British Museum, said to be from Japan. Mr. Busk now considerably adds to our information on the living types, and enters into several structural peculiarities observed by him.—The abstract of a contribution to the flora of Northern China, by Messrs. J. G. Baker and S. Le M. Moore was read. Some 600 specimens now deposited in the Kew herbarium, and collected by Mr. John Ross in the province of Selim King 40° to 42° N. lat. of the Celestial Empire, furnish the basis of this botanical contribution. Though many species among these are already known, yet the discovery of such forms as *Exochorda serratifolia*, an addition to a genus that has for years remained monotypic—*Saxifraga Rossii*, *Brachylites paridiformis*, and *Betula exaltata*—along with several altogether new species, render the collection valuable. These form a good adjunct to the researches on this relatively unfrequented region; but a knowledge of which is rapidly being accumulated, chiefly through the labours of Maximowicz, Hance, and Franchet.—The Rev. J. M. Crombie briefly indicated the substance of a reply by him to Dr. Stirton's remarks on his paper on the *Challenger* lichens.—Then followed a paper by Pastor H. D. J. Wallengren (of Sweden), on the species of Caddis flies (*Phryganea*) described by Linnæus in his "Fauna Suecia," with notes on, and communicated, by Mr. R. McLachlan. In this communication some twenty-five species undergo a critical revision and determination as identified from the living insects and Swedish entomological collections. Mr. McLachlan, however, does not concur with all the Pastor's conclusions.—On the Bell Bird, by Dr. J. Murie, was a paper taken as read.—Mr. Chas. Holme (Bradford) was elected a Fellow of the Society.

Paris

Academy of Sciences, June 23.—M. Daubrée in the chair.—The following papers were read:—On the absorption, by the atmosphere, of ultra-violet radiations, by M. Cornu. That the solar spectrum extends beyond what the most favourable observations present of it, seems probable from its almost sudden termination on the most refrangible side (in photographs), and the results of comparing this spectrum with that of iron vapour in the electric arc. The atmospheric absorption of ultra-violet radiations is demonstrated by introducing a tube 4 m. long, closed at the ends with fluor spar, between the collimator and the prism of a spectroscope. When the tube is full of air, line 32 of the aluminium spectrum (from electrodes of that metal transmitting the induction-spark) is invisible; but as vacuum is gradually produced, the line appears.—Remarks on a note of Admiral Mouchez, by M. Faye. He argues against the watchmakers being called on to determine experimentally the thermometric correction of the instruments they supply to merchant vessels. These vessels should have the same advantages as the navy in this respect.—Action of so-called poisons of the heart on the snail (*Helix pomatia*), by M. Vulpian. Alcoholic extract of onaye (*Strophantus hispidus*, D.C.), was taken as type of poisons stopping the heart with the ventricle in systole; *muscarine*, with the heart in diastole. The action in both cases was similar to that in frogs. The antagonism observed in mammalia between the effects of muscarine and those of sulphate of atropine, was also observed in snails. The hearts of crustaceans were not, apparently, affected by the two typical poisons named.—On an arithmetical property of a certain series of whole numbers, by Prof. Sylvester.—Inexact application of a theorem of dynamics, by MM. Bertin and Garbe, to explain the motion of the vanes of a radiometer. He disputes the assertion that the motion is produced solely by gaseous matters within the globe (the inference drawn by the authors named from a dynamical theorem). Considering the cause of motion complex, he suggests experiment in the direction of varying the substance and surfaces of the vanes with special regard to the calorific and luminous properties of the materials used; altering the luminous rays especially by polarising them in different directions relatively to the vanes; suspending the globe on two very fine points and inclosing it in a receiver exhausted of air.—On the means of working automatically the upper tube of the economising apparatus constructed at the sluice of Aubois, by M. de Caligny.—On the interoceanic maritime canal, by M. de Lesseps. Some preparatory operations are mentioned. Dr. Companyo, of Perpignan, who directed an important sanitary service in the Suez Canal works, has been sent to Panama to study the best means of preserving the health of workmen; and agents and correspondents have been charged to enlist the most suitable workmen in America.—M. Lissajous was elected Correspondent in Physics, in room of the late Dr. von Mayer.—Map of the solar spectrum, by M. Thollon. This new map, made with the aid of his powerful spectroscope in Italy, is 10 metres long, and contains about 4,000 lines (Ångström's contained 1,600 in a length of 3 metres). M. Thollon remarks on the singular resemblance of the groups A and B, and gives a four-fold classification of solar lines, viz.: 1. Nebulosity without nucleus. 2. Nucleus without nebulosity. 3. Nebulosity predominating. 4. Nucleus predominating. He describes the instruments with which he operated.—On the reappearance of phylloxera in vineyards subjected to insecticide operations, by M. Marion.—On the positions of the Comet Tempel II., 1867, deduced from four first observations at the observatory of Rio de Janeiro, by M. Cruls.—Resolution of systems of linear congruences, by M. Demeczky de Gyergyoszentmiklos.—Addition to a previous note on the series of Laplace, by M. de Saint Germain.—Study of the molecular constitution of liquids by means of their coefficient of expansion, their specific heat, and their atomic weight, by M. Pictet.—Explanation of the bolide at Geneva on June 7, 1879, by M. Oltramare. He considers such a phenomenon arises from electricity detaching a portion of the electrified cloud.—Study on alloys of lead and antimony and especially on the liquations and supersaturations they present, by M. De Jussieu.—On the production of hydrocellulose, by M. Girard. He gives three methods of producing it.—On the retrogradation of superphosphates, by M. Joulie.—On the respiratory apparatus of Ampullaria, by M. Sabatier.—Experimental researches on the therapeutic value of intravenous injections of milk, by MM. Bechamp and Baltus. The transfusion of milk within certain quantitative limits (comparatively extended) is harmless in the dog, but has too little therapeutical value to be substituted for transfusion of blood.—On the total absence of amnios in the embryos of the hen, by M. Dareste.—Prof. Draper presented a photograph of the solar spectrum and that of oxygen.

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THURSDAY, JULY 10, 1879

CLEMENTS' ORGANIC CHEMISTRY

A Manual of Organic Chemistry, Practical and Theoretical, for Colleges and Schools, Medical and Civil Service Examinations, and especially for Elementary, Advanced, and Honours Students at the Classes of the Science and Art Department, South Kensington. By Hugh Clements, of H.M. Civil Service. (Blackie and Son, 1879.)

A GOOD text-book should be correct as to facts and descriptions, so as to leave nothing for the student to unlearn; it should, without being tedious or cumbrous, be minute as to the information it contains, so as to spare the student the necessity of going over the same ground again; its arrangement should be thoroughly logical, building up the science from its first principles, and presenting it to the reader as a connected whole and not as a collection of dislocated and dissevered members; its language should be lucid, terse, and vigorous, in order to relieve the intellect and memory from any unnecessary strain; and, finally, it should be written by a person who not only knows the subject, but knows also how to teach it.

It is greatly to be feared that the encouragement offered by the Science and Art Department to the teaching of the various sciences included in its syllabus has not been productive of unalloyed good; it has called into existence a vast number of presuming and incompetent "science (so-called) teachers," and has undoubtedly been the ultimate cause of the deluge of illogical, incorrect, and imperfect text-books that has for years past flooded the educational market. These worthless and pernicious books naturally divide themselves into two classes, and it is very hard to tell which class is the more mischievous. In the first class we have the books that carry on their very faces conclusive evidence that they are written by individuals who know little or nothing of the subject they are pretending to treat—by men who have an enormous amount to learn before they can have anything whatever to teach. When these *savants* condescend to treat of experimental science, it becomes at once evident that they are writing about experiments they have never performed and apparatus they have never seen.

In the second class we have abler, but certainly not better books—these are the books written by fairly erudite authors, but written with a motive that is a disgrace to the author, an insult to the teacher, and a monstrous injustice to the student—they are the barefaced *cram books*—books written in order to enable the student to pass a specified examination, and not to aid him in obtaining any real knowledge of the subject. We are truly sorry to find that these miserable volumes are very extensively patronised and adopted by teachers, and if we are to judge from recent articles and speeches cramming and "spotting the questions" are considered not only legitimate but praiseworthy proceedings. For the credit of the teaching profession we are happy to say that there are many honest and able teachers with whom a correct and thorough knowledge of the subject is the first consideration, and a "pass" but a subordinate one; yet it must be confessed that an alarming number of teachers seem to think that "science teaching" consists in imparting to their students a few leading facts without any attempt at showing their connection or their bearing upon one another, and in getting them to learn, by *rote*, stereotyped answers to a few stock questions, trusting to chance that in one shape or another a sufficient number of these *stock questions* will turn up to enable their pupils to obtain at least 33 per cent. of attainable marks, and so entitle them to a "second class." Other teachers, considerably more able, but scarcely more conscientious, study the hobbies and the idiosyncracies of the examiners, and in the course of several years' practice manage to attain a wonderful amount of skill and success in securing passes. On the strength of this success they gain a pretty wide reputation as "excellent teachers," while in reality they impart to their pupils little or no knowledge of their subject as a science; all the information is conveyed and accepted on the mere *ipse dixit* of the teacher without any attempt at logical demonstration, and as a natural result teacher and taught get thoroughly imbued with a most pernicious dogmatism, which must be entirely eradicated before either becomes susceptible of any true scientific education. Much of the so-called science teaching has exactly the opposite effect to what the Science and Art Department intended it to have, and the money granted year by year has mostly gone to the pockets of successful crammers, while the honest painstaking teachers have had but a meagre share of the coveted loaves and fishes and a still more meagre share of fame.

Had Mr. Clements's volume been a solitary instance it would not have merited even a passing notice, but when we remember that it is only a specimen, and probably not the worst, of a rapidly-increasing class, we feel that as a representative of that class it deserves a fair and serious consideration. As some of the essentials of a good text-book, we have enumerated correctness and completeness as to facts and descriptions; when an author describes any process he should do it correctly and with sufficient minuteness to enable the student to comprehend every step of it, and, if he possesses the requisite apparatus, to go through it himself without further aid or direction. We shall quote from the book before us a few paragraphs relating to some of the simpler processes of organic chemistry, and let the reader judge how much assistance a student can derive from them. On pp. 3–13 the author gives directions how to perform "combustions" and the quantitative analysis of organic compounds generally. The engraving of the potash bulbs in Fig. 1, p. 4, is certainly misleading, and no one, either from the engraving or the accompanying explanation, could ever find out how the CO_2 finds its way to the bulbs *p*; if it was necessary to put in an engraving and a description of it at all, it was certainly quite as necessary that both should be correct and intelligible; at present they are neither. In his description of the method of determining the C and H in an organic compound, the author has hopelessly mixed up two distinct processes, viz., combustion in a closed tube and combustion in a current of air or oxygen. The tube in the engraving is represented as closed at one end, and there is no reference whatever to a tube open at both ends; consequently we fear that many students would attempt to introduce the platinum boat from the right-hand end of the tube. It may be said that their common

sense ought to show them otherwise; but when the author has had some years' practical experience, he will undoubtedly acknowledge that in scientific experiments very little reliance is to be placed on the common sense of beginners. The author says:—

"About one-fourth of the combustion tube is filled with copper oxide, the sugar weighed in a little glass tube, and shaken into the combustion tube and thoroughly mixed with the oxide by raking them together by a wire. The remainder of the tube is filled with oxide; or the sugar may be put in a platinum boat that will pass into the tube."

As an alternative, for *what* may the sugar be put in a platinum boat? It appears from the text that the boat is to be employed instead of filling up the "remainder of the tube with oxide." No further reference is made to the method of determining the C and H in organic compounds except on p. 11, where we are told that in the presence of nitrogenous substances the products of combustion must be passed over heated metallic copper, and we have failed to find a single hint to enable the student to determine the C and H in the presence of Cl, Br, I, S, or alkaline metals. All the processes given in the book, *supposing them to be intelligible to a beginner*, are utterly inadequate.

Referring to the determination of nitrogen, the author states (p. 12):—

"The ammonia process answers, except in cases where the nitrogen occurs in the form of nitric acid or cyanogen, when this element must be estimated by volume. This method is applicable in all cases. A combustion tube of about 32 inches long is taken, rounded like a test tube at one end. This tube is filled with some carbonate that, when heated, will give off carbonic anhydride, such as manganous carbonate, magnesite or hydric sodic-carbonate, and some mercuric oxide. A weighed portion of the substance for analysis, with upwards of forty times its weight of a mixture of oxide of copper and mercury, the rinsings of the mortar, a plug of asbestos, then about 4 inches of cupric oxide, asbestos and a layer of about 8 inches of metallic copper. The end of the combustion tube is drawn out and connected with a bent delivery tube, dipping beneath the mercury in the trough. When all is ready the carbonate in the tube is heated to generate a current of carbonic anhydride to drive out all the air.

"The metallic copper and copper oxide are heated simultaneously, and when the escaping gas is free from air, insert the end of the delivery tube through the tubulure of the vessel," &c., &c.

We suppose that Mr. Clements would barely maintain that the N occurs as *nitric* acid in nitromethane or any of its analogous compounds; but we should be very much surprised if he or any one else could make a correct determination of the nitrogen in those compounds by his ammonia method; and would it surprise him to learn that when N occurs as a component of cyanogen it may be correctly estimated by the ammonia method? What is the meaning of the remainder of the preceding extract? Having *filled* the tube with "some carbonate" and mercuric oxide, what is the student to do with the Benjamin's mess, the ingredients of which are enumerated in the next sentence, if a heap of words without a single predicate can be called a sentence? Without doubt the author meant a mixture of cupric and mercuric oxides by "a mixture of the oxide of copper and mercury," but a beginner, we should unhesitatingly say, would mix metallic mercury with oxide of copper if he had no other guide than this book. Then what mortar, trough, tubulure, and vessel are referred to? Where are they to come from, and what are they used for? A chemist may guess what is meant, but heaven help the beginner who tries to make his first nitrogen determination with the sole aid of this new light. We cannot believe it possible for a man who had ever "done a combustion" to have penned these pages 3-13.

We have neither space nor patience for further extracts from the author's description of processes and apparatus, but we would ask the reader to refer to pp. 164 and 165, where Messrs. Frankland and Ward's gas apparatus is described, and after he has read it let him try to find out how it was possible for a person who had ever seen the apparatus to write that description? or even if he had never seen it, how could he ignore the simplest principles of physics and propose to drive the gas from A by simply elevating M? The drawings and explanation are wofully incomplete and misleading.

It is needless to point out all the errors of the author, but there is one class we cannot help referring to, as it gives us a fair test of the extent of the author's knowledge of his subject. To translate constitutional to graphic formulæ is considered a very elementary exercise, but in this our author fails miserably; thus he gives (p. 219):—

$$\text{“ Succinic Acid}\left\{\begin{array}{l}\mathrm{COHo}\\ \mathrm{CH_2}\\ \mathrm{CH_2}\\ \mathrm{COHo}\end{array}\right. \qquad \begin{array}{ccccccccccc} & & & & \mathrm{H} & & \mathrm{H} & & & & \\ & & & & | & & | & & & & \\ \mathrm{H} & — & \mathrm{O} & — & \mathrm{C} & —— & \mathrm{C} & — & \mathrm{O} & — & \mathrm{H}\text{”} \\ & & & & | & & | & & & & \\ \mathrm{H} & — & \mathrm{O} & — & \mathrm{C} & & \mathrm{C} & — & \mathrm{O} & — & \mathrm{H} \end{array}$$

where the two lower atoms of C are represented as bivalent. On the same page he gives—

$$\text{“ Tartaric Acid}\left\{\begin{array}{l}\mathrm{COHo}\\ \mathrm{CHHo}\\ \mathrm{CHHo}\\ \mathrm{COHo}\end{array}\right. \qquad \begin{array}{ccccccccccccc} & & & & \mathrm{H} & & & & \mathrm{H} & & & & \\ & & & & | & & & & | & & & & \\ \mathrm{H} & — & \mathrm{O} & — & \mathrm{C} & — & \mathrm{O} & — & \mathrm{C} & — & \mathrm{O} & — & \mathrm{H}\text{”} \\ & & & & | & & & & | & & & & \\ \mathrm{H} & — & \mathrm{O} & — & \mathrm{C} & — & \mathrm{O} & — & \mathrm{C} & — & \mathrm{O} & — & \mathrm{H} \end{array}$$

where, as in the preceding, we have no oxatyl group in the graphic formula, although we have two such in each of the constitutional. Again, on p. 225 we have—

$$\text{“ Lactic Acid}\left\{\begin{array}{l}\mathrm{CMeHHo}\\ \mathrm{COHo}\end{array}\right. \qquad \begin{array}{ccccccccccccc} & & & & & & \mathrm{H} & & \mathrm{H} & & & & \\ & & & & & & | & & | & & & & \\ \mathrm{H} & — & \mathrm{O} & — & \mathrm{C} & — & \mathrm{C} & — & \mathrm{C} & — & \mathrm{O} & — & \mathrm{H.}\text{”} \\ & & & & \| & & | & & | & & & & \\ & & & & \mathrm{O} & & \mathrm{H} & & \mathrm{H} & & & & \end{array}$$

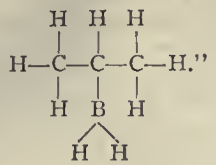
$$\text{“ Mercuric Ethide, HgEt}_2 \quad \begin{array}{ccccccccccccc} & & \mathrm{H} & & \mathrm{H} & & \mathrm{H} & & \mathrm{H} & & & & \\ & & | & & | & & | & & | & & & & \\ \mathrm{H} & — & \mathrm{C} & — & \mathrm{C} & — & \mathrm{C} & — & \mathrm{C} & — & \mathrm{Hg} & — & \mathrm{H.}\text{”} \\ & & | & & | & & | & & | & & & & \\ & & \mathrm{H} & & \mathrm{H} & & \mathrm{H} & & \mathrm{H} & & & & \end{array}$$

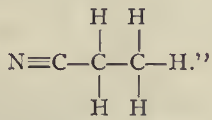
Where is the group Me in the first and the two groups of Et in the second? But to crown all he has begun this glorious page thus—

$$\text{“ Methylic Ether, }\left.\begin{array}{l}\mathrm{CH_3}\\ \mathrm{CH_3}\end{array}\right\}\mathrm{O} \qquad \begin{array}{ccccccccc} & & \mathrm{H} & & \mathrm{H} & & & & \\ & & | & & | & & & & \\ \mathrm{H} & — & \mathrm{C} & — & \mathrm{C} & — & \mathrm{O} & — & \mathrm{H.}\text{”} \\ & & | & & | & & & & \\ & & \mathrm{H} & & \mathrm{H} & & & & \end{array}$$

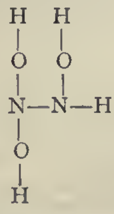
Is it possible that he does not know that this is the graphic formula of ethylic alcohol, EtHo, a very different compound indeed from $\mathrm{Me_2O}$? We will not multiply instances, though we might very easily do so;

but we cannot resist the temptation to cull the two following gems :—

P. 228—
"Boric Methide, $B(CH_3)_3$ 

P. 234—
"Allylamine, $N(C_3H_5)H_2$ 

It is a great pity the author ever meddled with graphic formulæ—he may have some very original notions about the constitution of organic bodies, but for his own credit he ought to have made his constitutional and graphic formulæ agree. The only thing we ever saw at all approaching the preceding in ridiculous incongruity was the following, handed to us by a beginner :—

Ammonic Nitrate, $NO_2(NH_4O)$ 

We kept this as a curiosity, little dreaming that we should ever live to see it surpassed in a text-book.

In no instance can we say that the information is complete and satisfactory, while in very many cases it is decidedly misleading. We fear that very few of the *model* answers to the questions of the Science and Art Department would have been marked "*excellent*" or even "*good*" by the examiners. For instance—

"30. How can you detect the presence of nitrogen in an organic substance?
Ans. "See the estimation of nitrogen."

We have looked again and again through the pages referred to, and certainly there is nothing there about the detection of nitrogen; does the author know any difference between detection and estimation?

"35. If an alkaline solution of potassic cyanide be boiled what decomposition takes place?
"The formiate of potassium is formed and ammonia thus—$KCN + 2H_2O = KCOHo + NH_3$."

This answer is brief, if not to the point, but what on earth is *KCOHo?*

"74. How would you separate alcohol from acetic acid?
"Acetic acid freezes at 17° C. or under, while alcohol remains liquid at much lower temperatures."

Very simple, but has the author ever tried it?

"99. What chemical changes ensue when a mixture of ethylic iodide and zinc are heated to 150° C. in a sealed tube?
"$2EtI + Zn = ZnI + 2C_2H_5$."

Is that all? We fancied hitherto that the merest tyro in chemistry knew better. We have neither space nor inclination to give further specimens of these answers, but let the reader refer to Nos. 100, 101, 102, &c., and judge for himself if the answers are satisfactory.

If we look at the arrangement of the book we must admit that we can find no sequence or logical connection between one part and another. Terms are employed before being properly defined, and often without being defined at all. We most sincerely pity the students who may attempt to learn organic chemistry by following the order of this book without having many a missing link supplied. Under the head "Alcohols" we have three mentioned—Methylic, Ethylic, and Phenylic; and by referring back to the "Theory of Compound Organic Radicals," we find mention made of several others, but no scientific arrangement in series and no general methods for the synthesis or preparation otherwise of the various terms of each series. The same objection applies more or less to the treatment of the ethers, aldehydes, acids, and anhydrides. By the way, we have not often seen carbamide or urea called a diamine, nor ethylic butyrate, C_3H_7COEtO called "*butylic* ether;" that term is generally reserved for $\left.\begin{matrix}C_4H_9\\C_4H_9\end{matrix}\right\}O$.

There are several pages giving nothing but the names and formulæ of compounds without any attempt to give their properties, their connection with one another, or the methods of preparing them; a few are referred to in other parts of the book, but necessarily they come before us then as isolated units and not as closely allied members of a consecutive series.

As to the language we need say but little. It is generally awkward or ambiguous, and often incorrect. The way pronouns and conjunctions are employed is sometimes alarming; in one paragraph of very moderate length we have the little word *or* occurring at least nineteen times, until we begin to think that the author has been taking the Apostle Paul for his model. In other places the pronoun *it* keeps dancing before our face like some imp, peering out of the most unexpected nooks and corners. Here is a model sentence—"A subsidence of temperature and an almost total absence of precipitated iodine after a few drops of the liquid remaining in the flask is boiled with HNO_3." What *is* boiled? is it the subsidence of temperature?

We have by no means pointed out the worst errors—we have purposely confined our remarks to the most elementary, and we think the reader will now be able to answer for himself whether the present author "knows his subject and knows how to teach it," or not.

One extract more and we have done with the book and its author, who says on p. 61 :—"Nitrous oxide and carbonic anhydride are other anæsthetics." Well, so they are, and we could only wish some people had the toothache "awful" and had the latter anæsthetic administered to alleviate their pain, and *ours*.

As we have said before, we have reviewed this book as a sample—and not the worst—of an ever-increasing class of publications, and we would ask teachers is it any wonder that "science teaching" has in many instances become a byeword and a reproach? Can we expect any different result until all sham-books and cram-books are consigned to the oblivion they so richly deserve?

E. H.

EUCLID AND HIS MODERN RIVALS

Euclid and His Modern Rivals. By Charles L. Dodgson, M.A. (London: Macmillan, 1879.)

Elementary Geometry. Books i.—iv., containing the subjects of Euclid's first six books; following the syllabus of geometry prepared by the Geometrical Association. By J. M. Wilson, M.A. Fourth edition. (London: Macmillan, 1878.)

BY a curious chance these two works reached our hands nearly on the same day, and as Mr. Dodgson devotes a great portion of his space (62 pp.) to the consideration of Mr. Wilson's Geometries, we have thought it well to notice the two authors at the same time. As however it is patent from the fact of Mr. Wilson's work having reached a fourth edition, that his method is not unknown to, and, may we add, not unappreciated by, a large section of mathematical teachers, we shall at once pass on to a consideration of Mr. Dodgson's book, only noticing Mr. Wilson's book in connection with the criticisms put forward in "Euclid and His Modern Rivals."

A few words by way of introduction. Mr. Dodgson has been a teacher of geometry at Oxford, we believe, for nearly five-and-twenty years, and during that time has had frequent occasion to examine candidates in that subject. For a great part of the above-stated period things went pretty smoothly, and King Euclid held undisputed sway in the "Schools;" but eleven years ago a troubler of the geometrical Israel came upon the scene, and read a paper before the Mathematical Society, entitled "Euclid as a Text-Book of Elementary Geometry." The agitation thus commenced acquired strength, and at length, in consequence of a correspondence carried on in these columns, the Geometrical Association was formed. A prime mover in this matter was that Mr. Wilson who wrote the paper, and subsequently brought out the geometry cited. Mr. Dodgson is one of the gentlemen opposed to this change, and the moving cause of the present Iliad is the "vindication of Euclid's masterpiece." Another consequence of the agitation is that many have tried their prentice hands on the production of new geometries—"rivals," our author calls them—"forty-five were left in my rooms to-day." Can we wonder then, that, his soul being stirred within him, he should overhaul a selection of them to see what blots he could "spot" in them? He might well have taken for his motto one once familiar to us—

> "If there's a hole in a' your coats,
> I rede ye tent it;
> A chiel's amang ye takin' notes,
> An' faith he'll prent it!"

Our author's criticism takes a peculiar form, but we shall not blame him for this, for he has afforded us much amusement, and we quite hold with the Horatian line he cites in extenuation of his mode of procedure: "Ridentem dicere verum quid vetat?" We believe he has made a good many hits, but at times his wit, we think, has led him too far. We shall not, however, here give any account of his plot—we prefer to refer our readers to the work itself—but confine our notice to the remarks upon Mr. Wilson's books, and upon Mr. Morell's "Euclid Simplified." [1]

Mr. Dodgson devotes forty-eight pages to Mr. Wilson's "Elementary Geometry" (second edition, 1869). We can hardly see why so much space should be devoted to a work which seems tacitly to have been withdrawn by the author, or, at any rate, to have been considered inferior to the work under review. Is it that the "scene" was written some time since, and was considered to be too good to be sacrificed? Happily it is not our business to defend Mr. Wilson's views on "direction;" he is perfectly competent to defend his own views, and no doubt, should he see fit, will do so at the right time.

"Minos"—who argues for Mr. Dodgson—himself seems to think that his remarks will now and again be considered hypercritical. Take the following:—

Niemand (the general representative of the "rivals," quoting from the "Elementary Geometry"). Two straight lines that meet one another form an angle at the point where they meet (p. 5). *Min.* Do you mean that they form it "*at* the point," and nowhere else? *Nie.* I suppose so. *Min.* I fear you allow your angle no magnitude, if you limit its existence to so small a locality! *Nie.* Well, we *don't* mean "nowhere else." *Min.* (*meditatively*). You mean *at* the point—and *some*where else? *Where* else, if you please? *Nie.* We mean—we don't quite know why we put in the words at all. Let us say "Two straight lines that meet one another form an angle." *Min.* Very well. It hardly tells us what an angle *is*, and, so far, it is inferior to Euclid's definition; but it may pass. Again (p. 73), *Nie.* reads, P. 5, Ax. 5, "Angles are equal when they could be placed on one another so that their vertices would coincide in position, and their arms in direction." *Min.* "Placed on one another!" Did you ever see the child's game, where a pile of four hands is made on the table, and each player tries to have a hand at the top of the pile? *Nie.* I know the game. *Min.* Well, did you ever see both players succeed at once? *Nie.* No. *Min.* Whenever that feat is achieved you may *then* expect to be able to place two angles "on one another!" You have hardly, I think, grasped the physical fact that, when one of two things is *on* the other, the second is *underneath* the first. But perhaps I am hypercritical.

What the text means is, of course, that B, C, D could be placed upon A or A upon B, C, D, so as to coincide. A still more striking instance is p. 160. Mr. Wilson adopts the syllabus-definition, "When one straight line stands upon another straight line and makes the adjacent angles equal, each of the angles is called a *right angle*"—a definition, by the way, remarkably like Euclid's. Minos says, "allow me to present you with a figure, as I see the Syllabus does not supply one—

A Here AB 'stands upon' BC, and makes the
B adjacent angles equal. How do you like these
C 'right angles?'"

This is a hit, of course, indeed a double hit, the one farcical in its illustration, the other sober enough, for the Syllabus considers that two angles (a major, and a minor, conjugate) are formed by two straight lines drawn from a point. Mr. Dodgson is very amusing upon the "straight" angle, and, no doubt, would be equally so upon the equivalent "flat" angle. A good phrase is still a desideratum, but De Morgan long ago pointed out that "the angle made by a straight line with its continuation is a definite angular magnitude," and considered its half to be the best definition of a right angle.

[1] A work we ourselves had occasion very strongly to condemn—see NATURE, vol. xiii. p. 202.

We pass over many passages we had marked, with saying that in many cases the objections are sound but trivial. Objection is taken to Mr. Wilson's remark, "Every theorem may be shown to be a means of indirectly measuring some magnitude," and Niemand abandons "every." We think, however, that Niemand might have made a better fight of it and suggested that what is intended is that, for instance, all the theorems of the first book are directly or indirectly required for the proof of the 47th Proposition, which is surely a proposition concerned with the measurement of magnitude.

On p. 177 Minos says of the exercise, "Show that the angles of an equiangular triangle are equal to two-thirds of a right angle. In this attempt I feel sure I should fail. In early life I was taught to believe them equal to *two right angles*—an antiquated prejudice, no doubt; but it is difficult to eradicate these childish instincts." Mr. Dodgson was taught that the *three* angles were equal to this magnitude; the question says "angles" surely in the plain sense of each angle being equal, &c. Again, in the construction for proposition corresponding to Eucl. i. 9 objection is taken to "finding a radius greater than half *A B*" (it should be *A C*): "it would seem to require the previous bisection of *A B*" (*A C*). Thus the proof involves the fallacy "*Petitio Principii.*" Surely one can take a line greater than or equal to *A C*; where, then, is the fallacy? Exception is taken to the proposition "the area of a trapezium is equal to the area of a rectangle whose base is half the sum of the two parallel sides, and whose altitude is the perpendicular distance between them" as being "a mere 'fancy' proposition of no practical value whatever." We have met with it in works on co-ordinate geometry and elsewhere. Then again the theorem (Apollonius's) on Mr. Wilson's p. 95 is branded "new," "but even with that mighty name to recommend it, I cannot help thinking it rather more curious than useful." It is our own impression that it is one of the most important "riders" from the second book, and if Mr. Dodgson has been teaching geometry for nearly five-and-twenty years, so have we—but we do not confine our teaching to the text-book only, we devote a great part of our geometrical teaching time to the working of exercises.

Our conclusion from the examination of Mr. Dodgson's objections to Mr. Wilson's last book is that the majority of them can be easily met; indeed, many of them are mere verbal quibbles; the rest arise from the very different standpoints taken up by the two writers, and here there is likely to be "war to the knife."

A word or two on Morell's (J. R.) "Euclid Simplified." It is very easy work to pick this little book to pieces, but we cannot understand a statement of Mr. Dodgson's on p. 148. Of the proposition "Every convex closed line *A B C D* enveloped by any other closed line *P Q R S T* is less than it," he says the method used fails, "as of course all methods must, the thing not being capable of proof." We cannot call to mind any English text-book in which the proposition is proved, but there is what we have thought was a proof in Sannia and D'Ovidio's "Elementi di Geometria," p. 32.

We are bound to say that "Euclid and his Modern Rivals" is not all amusing reading. It alternates

"From grave to gay,"

and more than a third part is devoted to appendices, the third to the sixth of which (73 pages) must have cost the author a great deal of thought and labour. We fear, however, it will not get the attention it deserves. It is hard reading, and one has hardly been led up to it by the amusement provided in the four Acts of the Drama. Some little trouble is involved in mastering the symbols and their significance.

The fourth act considers the objections brought by Mr. Wilson ("Euclid as a Text-Book," &c.) and others against the use of Euclid for junior pupils on the score of unsuggestiveness and want of simplicity of style, the exclusion of hypothetical constructions, &c. We need not consider them here, but refer to two articles by the Rev. Dr. Jones ("On the Unsuitableness of Euclid as a Text-Book of Geometry," *Trans.* of Liverpool Lit. and Phil. Society, published in a separate form; and "Review of Mr. Todhunter's Essay on Elementary Geometry," (*Monthly Journal of Education*, 1875, pp. 97-112, 150-160), neither of which is referred to by our author, though he quotes largely in the appendix from Mr. Todhunter's Essay and also from a review of Mr. Wilson's first Geometry in the *Athenæum* for July 18, 1868, written by Prof. De Morgan. We could instance other geometries which have an equal claim to be considered with any of those criticised by Mr. Dodgson, and we should rather have written "Euclid and *some* of his Modern Rivals."

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Papau or Papaye

IN NATURE, vol. xix. p. 447, is a paragraph relative to the singular qualities of the *Carica papaya*. I cannot but think that some of the properties attributed to this vegetal in British Guiana by the natives of that colony are exaggerated somewhat, *e.g.*, the tempering of steel by its sap, &c.

Sir Wyville Thomson, in the first volume of "The Voyage of the *Challenger*," gives a capital representation of a group of these papaw-trees in the garden of the Admiral commanding on the North American station at Clarence Hill, Bermudas, where they seem to abound; I do not know if these diœcious plants are indigenous to these islands or introduced from the West Indies and tropical America. From the cut above mentioned can be seen the quaint growth of these paradoxical trees, which must have been esteemed by the early voyagers, as they have been introduced into all parts of the tropics. The singular-looking straight stems (not unlike the gigantesque tree-cabbage stalks of the Channel Islands) are crowned with a tuft of digitate leaves, somewhat at a distance resembling those of the *Aralia papyrifera*, under which the clusters of black purple fruit protrude. In the islands of Bourbon and Mauritius they make a passable *compôte* of these fruit, which are pulpy and full of black seeds when ripe, and the Creole children eat them raw, with what effect on their insides I know not; the birds, however, will not touch them, and as they fall they rot on the ground beneath. In Mauritius, where we lived principally on ration beef cut from the tough flesh of Malagasy oxen, we were in the habit of hanging the ration under the leaves of the tree itself, and if we were in a hurry for a very tender piece of *filet*, our cook would wrap up the undercut of the sirloin in the leaves, when the newly-killed meat would be as tender as if it had been hung for a considerable time. Whence are these deleterious effects causing rapid decomposition of animal fibre? and are there any other trees which possess similar properties?

The Malabars, who were introduced into Mauritius as Coolies, would not sleep under tamarind trees, on account of their supposed noxious effects; but it is possible that superstition has something to do with their objection.

S. P. OLIVER

On the Origin of Certain Granitoid Rocks

DR. CALLAWAY's interesting letter with the above heading in NATURE (vol. xx. p. 219) tempts me to send you the following paragraph from my paper in the *Quart. Journ. Geolog. Soc.* for May, p. 286, in which the hälleflintas of the Arvonian there mentioned are first described:—

"The mode of behaviour of the quartz also here is particularly interesting and instructive in regard to the changes which many crystalline rocks have undergone, especially the gneisses. In some cases the quartz is seen in distinct fragments, but yet coalescing, as if attracted together by some natural affinity from the surrounding material. In the next place the grains are so compressed together (and yet distinctly fragmentary) that all other material is removed, and nests of pure quartz grains only are seen, having a very crystalline appearance. By this selective process also the darker material is brought together and made to fold round the nests, so that a banded or imperfect flow-structure is given to the rock. All this looks as if an incipient gneiss was being formed, the metamorphic action being incomplete, a kind of semi-metamorphism and softening having taken place sufficient only to allow the particles to arrange themselves according to their natural affinities."

It will be seen that the conclusions arrived at by Dr. Callaway in his recent examinations of similar rocks in Shropshire are almost identical with those previously formed by myself in Pembrokeshire. The careful microscopical examination of rocks of an intermediate type like these hälleflintas appear to be, cannot fail, I think, to clear up some of the difficulties hitherto experienced in endeavouring to explain the origin of many of the crystalline rocks.

HENRY HICKS

Hendon, July 4

Distribution of the Black Rat (Mus rattus, Linn.) in Italy

IT may interest the readers of NATURE to know that the black rat is very abundant and widely distributed in Italy and her islands. In the Central Collection of Italian Vertebrata which I have founded in the Florence Zoological Museum, I have a large series of specimens from no less than fifteen localities, viz., Domodossola, Casale, Florence, Radda, Arezzo, Castelfalfi, Lecce on the continent, Bastia (Corsica), Cagliari (Sardinia), Castelbuono Madonie (Sicily), and from the islands of Elba, Pianosa, Montecristo, Giglio, and Lipari. On the smaller islands the larger *M. decumanus* does not exist at all, but elsewhere the two species live side by side. In the Florence Museum we have *M. decumanus* in the cellars, and *M. rattus* upstairs. This proves that the black rat is very far indeed from extinction with us; I should say that it is generally more abundant in Italy than its larger congener, at least such is my experience.

I may add that we have *two*, if not three, very distinct varieties of *M. rattus*, viz., the typical *black M. rattus*, the grey and white *M. tectorum*, Savi, and the brown hirsute *M. alexandrinus*. The two former are positively one species, and I have them from the same litter; the latter is, I believe, generally admitted to be specifically identical with *M. rattus*.

HENRY H. GIGLIOLI

Royal Zoological Museum, Florence, July 4

Barbed Hooklets on Spines of a Brachiopod

MR. THOMAS DAVIDSON, F.R.S., describes, on p. 275, and figures, in pl. xxxiv. of the Supplement to his "Carboniferous Brachiopoda," now on the eve of publication, some important points in the structure of *Spirifera lineata*, Martin, which specimens in my collection have revealed. In this species the shell structure is minutely punctate, and the flattened spines, which are usually broken off short, contain in their interior a double canal, that terminates upon the outer surface of the shell in a series of double pores. I have recently been fortunate enough to find a specimen from the High Blantyre limestone shales having the spines in place. It appears that these spines are provided with numerous marginal opposite hooklets usually pointing towards the free end of the spine. So far as I am aware, this structure is unique amongst the brachiopods. Mr. Davidson has kindly undertaken to note this interesting fact in the explanation of the plates of his forthcoming monograph, the text having been printed off before this observation was made; but I should like to draw the attention of palæontologists to the point, as perhaps similar structures may be found in other brachiopods. The materials are in Mr. Davidson's hands for extended notice when his leisure allows him.

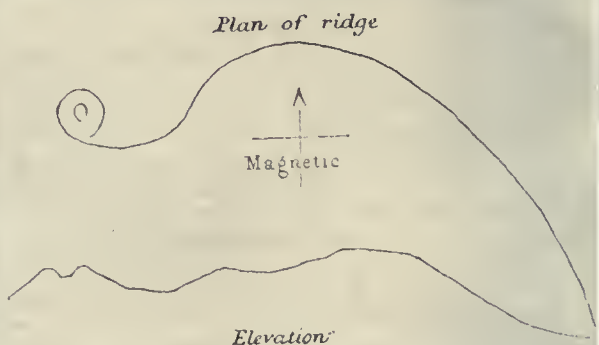
JOHN YOUNG

Hunterian Museum, Glasgow University, June

The Serpent Mound of Lochnell, near Oban

I WALKED over yesterday from here to examine this for myself. I started with some feelings of doubt as to whether it was not one of those fantastic shapes naturally assumed by igneous rocks, seen through the spectacles of an antiquarian enthusiast. I came away quite satisfied that it is an artificial shape, designedly given, and deliberately intended to represent a snake. It partly closes the entrance of a singular little rock amphitheatre with a waterfall at the head (the north end of it), the Loch being to the southward. There is a raised plateau to the northward of the serpent, nearly square. The ground is apparently a rubble of gravel, stones, and dirt, such as is found in moraines. The head of the snake had been opened, and showed a quantity of stones with some indication of a square chamber in the middle.

I do not pretend to any antiquarian knowledge. The impression that it suggested to me, on the spot, was that a party had endeavoured to entrench itself, at the spot, but had been attacked before the entrenchment was complete on more than one face, and that the rampart was then converted into the snake form to commemorate either a successful assault, or the successful defence of an unfinished work.



I inclose you a sketch plan and elevation, of a very rough kind, which I made on the spot and have not retouched since, except by inking over my pencil marks.

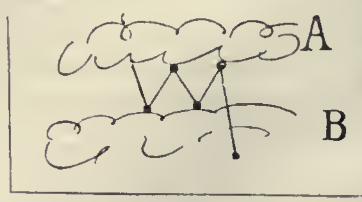
You have already (some years back), given a drawing and description of it. It should be stated that it is at the north-west corner of Lochnell, close alongside of the road from Oban to Callanach.

C. W. M.

Oban, June 19

The Origin of Hail

I SHOULD feel much obliged if any of your readers would kindly explain for me the following "explanation" of the origin of *hail;* which I have come across while reading for an examination:—



"*Hail.*—It consists of concentric layers of ice, and is caused by electricity. Imagine two clouds, A and B, charged with different fluids, and suppose that a drop of water falls from A. Its

fall will be very rapid, both on account of gravitation and attraction, and (*a*) *the evaporation will be so great*, that it will be *frozen*. On touching the cloud B it *condenses* (*b*) *part of its vapour*, gets thus a coating of ice, and, having the same fluid as B, it will be repelled towards A, and so on, downwards and upwards, until it becomes heavy enough to fall to the ground."

My difficulties are the following :—Whence comes the evaporation spoken of at (*a*)?

According to the above, when it reaches B it is frozen. What then am I to understand by the "condensation of part of its vapour (*b*)?"

Also, would not the two clouds, A and B, having opposite fluids, themselves unite?

If you will kindly solve me these difficulties you will greatly oblige an IGNORAMUS

Butterfly Swarms

WITH reference to the case mentioned in NATURE, vol. xx. p. 220, I agree with your correspondent that "local fecundity" cannot be the cause of the great number of *Vanessa cardui* observed this year in the south of England, more especially as this species does not emerge from the chrysalis until the end of July at the earliest. It therefore appears to me probable that the specimens observed have migrated (having hybernated) from the Northern Counties or even from Scotland, in consequence of the exceptional severity of the weather this season. I would also suggest that the "periodical abundance" of this butterfly, as also that of *Colias hyale* and *Edusa*, besides several others, may be caused by some peculiarity in the food-plant itself. This is rendered more likely by the fact that both *Colias hyale* and *Edusa*, which feed upon plants of the Leguminous order, and often of the same species, appear in great abundance at the same period.

I may mention that where I reside I observed many specimens of *Vanessa cardui* last year (1878). In the preceding year (1877) both *Colias hyale* and *Edusa* were exceedingly plentiful, whereas last year (1878) I did not see a single specimen of either of these butterflies. F. H. HAINES

The Buses, Edenbridge, Kent, July 7

MR. J. H. A. JENNER says (NATURE, vol. xx. p. 220) that "last season (1878) he saw no specimens of *Vanessa cardui*, nor did he hear of any about Lewes." I would remark that *Vanessa cardui* was exceedingly abundant in the Isle of Wight; I could have caught scores in a few minutes. I would further remark that towards the close of the season I saw beds of nettles, many yards square, literally black with larvæ of *V. cardui*.[1] I anticipated then that they would be abundant this year, and so they are. W. REES SWAIN

Patent Museum, South Kensington, July 4

Intellect in Brutes

As an instance of intelligence in a cat, the following story is, I think, worthy of being recorded in your pages :—

My father, when a boy, kept a tame starling, which, having had its wings clipped, was allowed to hop about the house at random. It had been brought up, so to speak, with a little kitten, and a great friendship had been established between the two, they playing together, drinking out of the same saucer, &c., &c.

One day while the family were at dinner, with open doors, the cat suddenly pounced upon the starling, and every one thought that at last the cat's nature had got the better of its affection; but no. The cat carefully took up the starling, jumped with it on to a table, and leaving it there, rushed out of the room.

A moment after, the sound of a furious fight going on in the hall reached the ears of the astonished family, and it was then found that a strange cat had stolen into the house, with which the starling's friend was fighting. Evidently the house cat heard the approach of the enemy, and having first placed its playfellow in a comparatively safe place, rushed out to expel the intruder. A. DUPRÉ

Kensington, W., July 5

[1] [The larvæ referred to were probably those of *V. atalanta*. *V. cardui* ordinarily feeds on *thistles*.—ED.]

THE letters of X. and of Mr. Henry Clark in NATURE, vol. xx. p. 220, referring to the recognition of portraits by dogs, are, I think, very interesting, as my observations lead me to suppose that it is very rarely that a dog takes any notice of a painting or any representation on the flat. I only know of one instance. A bull terrier of mine was lying asleep upon a chair in the house of a friend, and was suddenly aroused by some noise. On opening his eyes, the dog caught sight of a portrait of a gentleman on the wall not far from him, upon which the light was shining strongly. He growled, and for some little time kept his eyes fixed upon the portrait, but shortly satisfying himself that there was no danger to be apprehended, he resumed his nap. I have often since endeavoured to induce him to pay some attention to portraits and pictures, but without success; but sometimes he will bark at his own reflection in a looking-glass. He knows it to be his own image that he sees, for he very soon tires both of barking and looking. Other authentic instances of this kind would be valuable. J. B. R.

July 4

I SEND the inclosed extract from the *Bedworth Guardian*. I can vouch for the fact, as Hawkesbury Station is near to me, and my son has witnessed the feats of poor Pincher. I trust that it will not be an unwelcome contribution to the interesting series of facts in evidence of animal sagacity recorded in NATURE.

Moat House, Walsgrave, Coventry, July 3

J. S. WHITTEM

"The picturesque little station at Hawkesbury Lane, between Nuneaton and Coventry, has, for some time past, been the home of a fox terrier, known as Pincher, an animal possessing almost human intelligence. Pincher—trained by its owner, Mr. Instone, to do so—would listen with marvellous patience and acuteness for the signal intimating that a train was approaching the station, and then, almost with the speed of lightning, rush to the signal-box, and, seizing the bell between its teeth, shake it heartily, and thus apprise the waiting passengers of the train's approach. This task accomplished, he would descend the steps leading from the box, proudly wagging his tail, and ready and willing, apparently, for any duty he might be called upon to perform. Often, as a train was leaving the station, Pincher would run beside it for about a hundred yards, as though acting under the impression that the engine-driver would be unable to obtain the necessary impetus without his assistance. On Sunday evening last Pincher's career was brought to an untimely end, but he died as became a dog of his attainments and renown, "in harness." Soon after seven o'clock on the evening named, two trains entered the station at one and the same time (Pincher having previously rung the bell), one going towards Nuneaton, the other in the contrary direction. Actuated by some motive or other—probably to see what was going on at the other side of the line—the dog darted under the carriages of the latter train, and one of the wheels passed over his neck, death being instantaneous."

Snails *v.* Glow-worms

WHEN writing on this subject I thought my facts might be questioned, but I did not expect they would be so distorted as they have been by Mr. McLachlan at p. 219.

I simply recorded what I had seen, and in accordance with the request at the head of your column for letters to the Editor, I made my letter "as short as possible."

The heading of my letter was correct, and I described what I certainly saw—a glow-worm in *the inside* of a snail, for when the snail moved its semi-transparent skin was between me and the light. There was no phosphorescent matter on the snail.

If the glow-worm was eating the snail, as both Mr. McLachlan and Mr. Greenwood Penny suggest, then, I conclude, he attacked *the liver*, and not the *lights*, as Mr. Henslow's cat did! At all events my opponents will agree with me in thinking that the snail had a *light* supper! The fact is evidently new to these gentlemen.

I shall feel obliged by any or all of them sending me some glow-worms, and I will try the experiment again, as well as some others. R. S. NEWALL

Gateshead-on-Tyne, July 8

Occurrence of Boar Fish

I RECEIVED several notices of the capture of boar-fish (*Capros aper*), on the south and south-east coasts of England during June

last. First from Bournemouth and Weymouth, where they were found not unfrequently dead on the shore. Again, one of the Leigh "shrimpers" took about a dozen specimens in his trawl net near Sheerness, at the mouth of the Thames. Another two specimens were taken likewise in a shrimp trawl off Harwich. None of these survived, no doubt having been too long in the trawl net, which is frequently three or more hours in the water. Dead specimens of these were sent for my observation, by Mr. Andrew, the aquarium fish collector of Southend-on-Sea. He says the Essex fishermen call them red dorees, but none remember having seen them on that coast before this year.

JOHN T. CARRINGTON

Royal Aquarium, Westminster, July 6

Habits of Ants

MY attention was lately called by a friend to the operations of a party of ants. The theatre of their work was a cherry-tree partly decayed in the centre. From this portion of the tree the busy creatures were bringing forth small grains of sawdust-like *débris*. These particles were conveyed to the prominence left by an amputated branch, and thrown over to the ground, a distance of about five feet. The particles were passed on from one ant to another—as water-buckets were at old-time fires. Nor was this all, for on the ground below, another party removed the accumulated material. In this connection the reader should consult a remarkable note on page 21 of Kerner's "Flowers and their Unbidden Guests" to further illustrate the intelligence of ants and their recognition of the principle of division of labour. I am unable to state the species of ant I observed, as I am not an entomologist. It was a rather large red ant.

W. WHITMAN BAILEY

Brown University, Providence, R.I. (U.S.), June 17

WILLIAM FOTHERGILL COOKE

THERE has slipped away noiselessly and quietly one of England's scientific pioneers and one of the world's benefactors. Sir William Fothergill Cooke was the father of electric telegraphy. Born in 1806, educated in Durham, where his father was a professor, he joined the East India Company's military service in 1826, from which he retired in 1835 to study anatomy and physiology in Paris and Heidelberg. He was very clever at wax modelling. In 1836 a lecture on Schilling's telegraph directed his attention to the electric telegraph. His was the active sanguine mind that saw the great future of telegraphy before him, and that, in spite of supineness and unbelief, forced the new agent on an unwilling world. He was not an inventor nor a discoverer, but he was a far-seeing, practical man, with a determined will, indomitable energy, and of great resources. Associated with Wheatstone, he established telegraphy as a commercial undertaking. The first experimental line in England was put up in 1837. The first Electric Telegraph Company was incorporated in 1844. The first cable was laid in 1851. Now the world is one network of wires, and while the pioneer of this great system is carried to his grave, representatives from every civilised nation of the earth meet in telegraphic parliament in London without heaving one sigh or casting one thought

"O'er the grave where our hero we buried."

THE COMPARATIVE ANATOMY OF MAN[1]

II.

The Andaman Islanders (continued)

HITHERTO the osteological characters of these people have only been known from one skeleton, briefly described by Prof. Owen, two crania by Mr. Busk, and two by Prof. Quatrefages. During the last half year, the College museum has received a valuable series of skeletons, collected, at the request of Sir Joseph Fayrer, by the late Dr. J. Dougall, senior medical officer at Port Blair; others have been lent for the purpose of illustrating this course by Professors Rolleston and Allen Thomson, amounting altogether to nineteen skeletons, and about thirty crania.

The common estimate among Europeans, which is fairly correct for averages, is that the length of the femur is to the height of the living person as 275 is to 1,000. Only one of the above-mentioned Andamanese skeletons has been articulated, but this shows exactly the same proportion. Calculated on this basis, the average height of the skeletons of males would be 4 feet 9 inches, the tallest being 5 feet 3 inches, and the shortest 4 feet 6 inches. The average height of the ten skeletons of females would be 4 feet 6 inches, the tallest being 4 feet 10 inches, the shortest 4 feet 3 inches.

Attention was first drawn to the fact that the proportions of the different segments of the limbs might differ in various races by the announcement in 1799, by White, of Manchester, since amply confirmed, that the forearm of the Negro is proportionally longer than that of the European. Unfortunately, skeletons of most races are so rare in collections, that we have at present but few reliable data on this subject, and it is only when a sufficient number can be obtained, on which to found a fair average, that any satisfactory law can be established.

The first ratio, or index, is that obtained by the comparison of the entire upper and lower limbs with each other, the *intermembral index*, or the length of the humerus and radius added together, as compared with that of the femur and tibia, the latter being taken as 100. This ratio, in the nineteen Andaman skeletons, is 68·3; in fourteen Europeans, measured in the same manner, 69·2, showing a slight diminution in the length of the arm of the former, as compared with the latter. This has been also found by Broca, to be the case with African Negroes. The *femoro-humeral index* is the ratio of the humerus to the femur, the latter being taken as 100. In Europeans, according to Prof. Flower's and Broca's measurements, this is 72 to 73; in Negroes, according to Broca, 68·9; in the Andamanese, 69·8; showing that in both the latter races the humerus is relatively shorter than the femur. The *femoro-tibial index* is the length of the tibia to the femur, the latter being 100. In Europeans, this is 82; in Negroes, according to Prof. Humphry, 84·7; in the Andamanese, almost exactly the same, 84·5. The *humero-radial index*, or the length of the radius, compared to the humerus is, perhaps, the most important, as being subject to greater variations in different races. In nine Europeans measured by Broca, it is 73·9; in fourteen Europeans in the College Museum, it is exactly the same; in fifteen Negroes measured by Broca, 79·4; in the nineteen Andamanese, 81. Thus the differential characters of the Andamanese, as compared with Europeans, in respect to the proportions of the limb-bones, lie mainly in the greater length of the distal segment of each limb as compared with the proximal segment, a peculiarity most especially manifested in the upper extremity.

In the *Bulletin* of the Paris Anthropological Society of last year, Broca called attention to the form of the scapula as a race-character, and showed that one of the principal modifications of the form of this bone could be expressed by an index formed of a ratio between the two chief diameters of the bone, *i.e.*, the length from the posterior superior angle (C) to the inferior angle (D), and the breadth from the middle of the posterior margin of the glenoid cavity (A) to the point on the posterior or vertebral border from which the spine arises (B). The ratio of the length (C D) to the breadth (A B), the latter being 100, is called the *scapular index*. In the anthropoid apes the index varies between 70 and 100, and in most of the lower forms of monkeys and other mammals, it is considerably higher. A high index is, therefore, a sign of inferiority. Broca found that the average in

[1] Abstract of Prof. Flower's Hunterian Lectures, delivered at the Royal College of Surgeons, commencing on Wednesday, March 5. Continued from p. 225.

twenty-three Europeans was 65·91, and in 200 scapulæ of Europeans, measured by Dr. Garson, the average index was 65·2. The twenty-five Negro skeletons in the Paris Museum gave an average scapular index of 68·16, and the six scapulæ of the three Negro skeletons in the College Museum, 71·7. Australians give an average of about 68·9. Of the Andaman skeletons, the twenty-one scapulæ which have the epiphyses united give an average index of 69·8, and thus, in this character also, they stand in close relationship to the Negro and to the Australian. Another sign of inferiority in the scapula of the Andamanese is the almost constant absence of the supra-scapular notch.

The pelvis is also very important for comparison, and the difference that is most obvious and easily estimated lies in the form of the superior aperture or brim, which is always more elongated from before backwards, and narrowed laterally in the apes than it is in man. The relation of the antero-posterior to the transverse diameter of the brim, the latter measurement being taken as 100, gives the *pelvic index*. In the anthropoid apes the antero-posterior diameter is always the larger, and in infancy and childhood in our own race the pelvic index is also as high as, or above, 100. In adult man, except in rare cases, the transverse diameter is the greater, and the index consequently below 100, in the female being lower than in the male. In Europeans the average pelvic index is about 81 for the male and 78 for the female sex. The average of 17 male Negroes, according to Verneau, is 89; of ten Australians, according to Prof. Flower, 98; but the Andamanese give the highest figure of all, the average index of 8 males being 101, the maximum being 116 (the highest index of a human pelvis recorded), the minimum 92·6. Of the 9 females the average index is 95·2, the maximum 107·8, the minimum 86·4. No race, of which a sufficient number of pelves to give fair averages have been measured, has shown a form of the pelvis departing so widely from the European type. It should be noted, however, that the difference between the sexes is as fully, or even more fully, pronounced than it is in the higher races, contrary to an idea which has been sometimes held, based, however, upon an insufficient number of observations.

Cranial Characters.—The following observations are founded upon twenty-four specimens, all adults, of which twelve belong to the male and twelve to the female sex. They all present a very considerable general resemblance. They present a peculiar combination of characters, which distinguish them from the crania of all other races, unless it may be some of the closely allied Negrito population of the Indian Archipelago. Among these twenty-four skulls none present any artificial or pathological deformation.

In general size the skulls may be considered as belonging to the smallest, or nearly the smallest, of any race. The cranial capacity of the males ranges between 1,150 and 1,360 cubic centimetres, the average being 1,244 c.c. (76 c. ins); that of the females between 1,025 and 1,250 c.c., the average being 1,128 c.c. (69 c. ins.), the proportion between the two sexes being, therefore, as 1,000 to 906, almost exactly the same as that between English men and women. The average circumference in the male is 480 millimetres; in the female, 462 millimetres.

The general form of the cranium is short and round, and the parietal region is greatly developed at the expense of the frontal, and especially of the occipital regions. The relation of the greatest transverse breadth in the parietal region to the length is expressed by the *latitudinal index* (sometimes called "cephalic index"). This in both sexes averages 820, and they are therefore, as a race, truly brachycephalic, all those skulls, the index of which is above 800, coming into this category. The average index of height—*altitudinal index*—in both sexes is 775, being 770 in the males and 779 in the females. In only one out of the twenty-four skulls is the breadth less than the height; they thus differ greatly from the Papuans and Melanesians.

The sutures of the cranium are, as in most inferior races, rather simple. *Metopism*, or persistence of the mid-frontal suture throughout life, occurs in four out of thirty-four known cases of skulls of Andamanese, and thus seems rather more frequent than among Europeans; this is rather surprising, as it is a character which generally accompanies superiority of development. More skulls, however, must be examined to establish the actual frequency of its occurrence in the race. The disposition of the sutures in the region called *pterion* by Broca, where the frontal, parietal, squamosal, and alisphenoidal bones meet, is always worthy of note in estimating the differential characters of races. In many inferior races the interval between the frontal and squamosal bones is greatly diminished, and often, especially among the Melanesians, disappears altogether, the squamosal then directly uniting with the frontal. Very frequently small independent ossicles, or *epipteric bones*, are interposed.

In the Andamanese the pterion is usually very narrow, but in six only out of forty-six cases examined (taking both sides) did the squamosal reach the frontal. In eight cases epiteric bones were developed. The general surface of the cranium is smooth, and the muscular ridges little pronounced. The forehead is rounded and even, and the glabella and superorbital eminences are always very little developed. The interspace between the orbits is wide and flat, and the orbits are round, the average index, or the ratio of height to width of margin, the latter taken as 100, being as high as 910. The nasal bones are straight, with nearly parallel sides, and not prominent. The width of the nasal opening brings the Andamanese into the mesorhine category of Broca, though approaching the platyrhine, the average index being 512. Of the twenty-four skulls, five are platyrhine, seventeen mesorhine, and two leptorhine. With regard to the projection forward of the jaws, eleven are decidedly prognathous, eight mesognathous, and five orthognathous.

Comparison with other Races.—With the Australians, the Andamanese have very little affinity; it is to the other wooly-haired races that we must naturally turn in endeavouring to find their nearest relatives. The typical Melanesians and Papuans differ greatly in their principal cranial characters; the Tasmanians, also, differed widely from the Andamanese. Many of the African Negroes, again, although usually dolichocephalic, extremely prognathous and platyrhine, have the smooth brow and round orbit seen in the Andamanese, and not generally met with in the true Oceanic Negroes.

The natives of the Andaman Islands, with whom may probably be associated the less known Aetas of the Philippines, the Semangs of the Malay Peninsula, and some other scattered races of the Indo-Malay Peninsula, thus constitute a race apart, to which the name *Negrito* may properly be applied. At first sight, they appear in their craniological characters to present little affinity to either of the other woolly-haired races, but it is probable that they represent a small or infantile type of the same primary group. It is very possible, but this is purely hypothetical, that the Andamanese may be the unchanged or little modified representatives of a primitive type, from which the African Negroes, on the one hand, and the Oceanic Negroes on the other, have taken their origin, and hence everything connected with their history or structure becomes of the greatest interest to the anthropologist.

The Inhabitants of India

By their physical characters, the various populations which inhabit the great continent of Asia attach themselves more or less to one or other of two very distinct types:—I. The *Mongolian;* and II. That which for want of a better name must still be distinguished by the title applied to it by Blumenbach, the *Caucasian.*

Roughly speaking, a line striking northward from the head of the Bay of Bengal, to the Himalayas, then turning westward and skirting the southern flanks of that great mountain-chain, passing north of Cashmere, and in a westward direction to the Sea of Aral, the Caspian, and the Ural Mountains, divides the area occupied by people of each type, those to the east and north of this line being mainly Mongolians, and those to the south and west mainly Caucasians.

The people of India proper, except in the extreme north and north-east, belong mainly to the Caucasian division. It has been thought that other races have contributed a share to the composition of the present population of the Peninsula, having been the earliest inhabitants of the land, and forming, as it were, a substratum of the existing population; these are :—I. Negritos, allied to the Andaman Islanders: II. Australoids, allied to the modern Australians. The search for evidence for or against the existence of these elements in the population of India must naturally be sought for among the tribes which retain more or less of their barbarous condition.

With these must be classed the Veddahs of Ceylon. Many of these people have become civilised, but the wild or "Rock Veddahs" live in a most primitive state of social culture, without clothing, agriculture, or fixed dwellings. They are a dwarfish, stunted race, of blackish complexion. and with straight, though generally unkempt and shaggy hair. The condition of their bones and other physical characters give the impression of their being a race degenerated and enfeebled by generations of privation and other circumstances adverse to full development. There are no Veddah skeletons in the College Museum, but as many as seven crania; one of them, that of a woman, is the smallest adult skull in the whole collection, its cerebral capacity measuring only 960 c.c. (58·6 c. ins.). They are all dolichocephalic, the average latitudinal index being 71·1, and the average altidudinal index 86·1. Their prognathism is not very marked, and the nasal index is medium, averaging 50·3. They enter rather into the type of the lower grades of the inhabitants of Bengal.

The present population of India, excluding the Mongoloid people of the north and east, is separated by language into two great divisions—(1) The Aryans, and (2) The Non-Aryans, the majority of whom speak one of the agglutinative tongues collectively called *Dravidian*. The Aryans came into India by the north-west by way of the Punjaub, about 1,500 years before our era, as is supposed. They now occupy the great alluvial plains of the Indus and Ganges between the Himalayas and the elevated plateau of Central India, and have spread southwards along both coasts as far as Ceylon.

The Dravidians, who occupy the greater part of the country southwards from the Nerbudda River, are supposed to be descended mainly from the people who inhabited the country before the Aryan immigration. They are again divided into two groups—(*a*) The civilised Dravidians, speaking Tamul, Telugu, Canarese, &c., and (*b*) The wild tribes of the mountainous districts of the interior. These "Hill Tribes," as they are often called, are of great interest to the ethnologist, as they represent the oldest stratum of the population. By their languages they are divided into two groups—(1) Those that speak Dravidian, the Gonds, the Khonds, the Oraons, &c.; (2) The Munda or Kolarian family, composed of numerous tribes called Coles, Hos, Moondahs, Santals, Billahs, &c. Very little is known of the physical characters of these people.

Dr. John Shortt has lately sent to the Museum a series of twenty skulls belonging to the tribes of Maravars, who inhabit the Madura district in the south of the peninsula. He has also sent a series of equal number to the Museum of the Paris Anthropological Society, which has been described by M. Callamand in a recent number of the *Revue d'Anthropologie*. As regards the capacity, the average in the Paris skulls is 1,281 c.c., in those sent to the Museum, 1,268 c.c. The average lengths are respectively 174·5 and 175·6, but in the former the projection of glabella is included. The average breadth is 131 in both; the latitudinal index is 746 in the one and 751 in the other series; the altitudinal, the nasal, and the orbital indices are respectively 752 and 758, 521 and 510, 839, and 854. These skulls, on the whole, differ totally from those of the Andamanese, especially in the great development of the occipital region. Nor do they present any striking resemblances either to those of the Australians, or to any of the Mongoloid races. Their characters do not differ much from those of the mixed population of Bengal generally. These Maravars may not belong to the races among which the characters of the original hill-tribes should be looked for, and no evidence has yet been found of cranial conformation bearing out the view of the Australian affinities of these people, derived from external appearance. The presence of a Negrito, *i.e.*, woolly-haired and brachycephalic, element in the population of India, is also based at present on very slender evidence.

(*To be continued*)

ON THE SECULAR EFFECTS OF TIDAL FRICTION[1]

IN three papers, read at different times before the Royal Society, the author has considered the theory of the tides of a viscous spheroid, and the perturbations of the rotation of the spheroid caused by the attraction of the tide-raising satellite; the direction of that investigation was governed by considerations of applicability to the case of the earth, moon, and sun.

In the paper, of which we are here giving an account, the question is considered both from a more general and from a more special point of view than in the previous papers. For it is here supposed that there is only a single tide-raising body or satellite which moves in a circular orbit in the equator of the planet, but the orbital motion may be either consentaneous with or adverse to the planet's rotation. The tides supposed to be raised in the planet by the attraction of the satellite are of any kind whatever, provided that there is a frictional resistance in the planet to the tidal motion. The results are therefore applicable alike to the hypothesis of bodily tides, or to that of oceanic tides.

It results from a general mechanical principle that in whatever way the satellite and planet interact, the whole moment of momentum of the rotation of the system must remain constant; whilst, as there is a frictional resistance in the planet to the tidal motion, the whole energy of the system, viz., the sum of the potential and kinetic energies, must diminish. The method employed to trace the effects of tidal friction consists in drawing two curves, one of which represents the constancy of the moment of momentum, and the other of which gives the energy of the system for each configuration.

Then if we conceive a system of a planet and satellite started in such a way as to be represented by a given point on the curve of conservation of moment of momentum; and if we imagine this point linked to its corresponding point on the curve of energy, since the energy must degrade, the point on the curve of energy must always slide down a slope and carry with it the point on the curve of momentum.

It is thus possible to track the nature of the changes in the configuration of the system, but the method gives no clue to the time occupied by those changes. This comparison of the energy with the moment of momentum of the system by a graphical method was suggested to the author by Sir William Thomson.

[1] A paper read before the Royal Society on June 19, 1879, by G. H. Darwin.

A third curve is also introduced which represents such a rotation of the system that the planet always shows the same face to the satellite, just as we always see the same face of the moon; this curve is called the curve of rigidity, because when the motion is of this kind, the system moves as though the planet and satellite were parts of one rigid body.

It appears from a consideration of these three curves that if the whole momentum of the system be less than a certain amount, then it is not possible to set a given planet and satellite in rotation, so that the planet shall always show the same face to the satellite; but if this can be done at all, it can be done in two ways, and one of those ways corresponds to a maximum amount of energy of the system, and the other to a minimum. Moreover the configuration of maximum energy is one of dynamical instability and the system may degrade in either of two ways from that state. In one of these modes of degradation the satellite approaches and falls into the planet, and in the other it recedes from the planet.

Part of the author's previous papers consists in tracing backwards the moon's motion from its present condition to that configuration of maximum energy; and it was found that that state corresponded with a rotation of the earth and moon, like the parts of one rigid body, in about five hours. This rapid periodic time of the moon corresponds with only a few thousands of miles intervening between the earth's surface and that body. Since the tides on the earth must be subject to friction, it follows inevitably that, if time enough has elapsed since the origin of the moon and earth, the present state must be a degradation of the configuration of maximum energy, which cannot itself be a degradation of a previous state. And therefore it was maintained that this closeness of the two bodies points to the community of their origin.

In this mode of evolution we see that the rotation and revolution of the two bodies was primitively such that the month and day were of equal length (about five hours), and that in the future they will again come to equality, each being then about fifty of our days long. From this it follows that the system must pass through some phase in which there is a maximum number of planetary rotations during one revolution of the satellite, or shortly there must, at some time, be a maximum number of days in the month. Numerical calculation shows that for the earth and moon that maximum number is about 29, and that at present, when we have $27\frac{1}{3}$ days in the sidereal month, we have slightly passed that maximum.

From a further consideration of the figures it appears that if the planet and satellite are set in motion with opposite rotations, the satellite will fall into the planet if the moment of momentum of orbital motion be less than or equal to, or only greater, by a certain critical amount than the moment of momentum of planetary rotation; but if it be greater by more than a certain critical amount the satellite will approach the planet, the rotation of the planet will stop and reverse, and finally the system will come to equilibrium when the two bodies move round as a rigid body, with a long periodic time.

If the rate of the planet's rotation be less than that of the satellite's revolution, so that the sidereal month is shorter than the day (as with the inner satellite of Mars), then the satellite will either approach the planet and ultimately fall into it, or will approach the planet and will finally move round the planet at the same rate as the planet rotates. It depends on the nature of the system, as to which of these two cases will be the result.

The method is then extended to the case where the satellite, instead of being merely an attractive particle, is also a spheroid rotating about an axis perpendicular to the plane of the orbit. In this case the graphical illustration is by means of surfaces, there being one surface representing conservation of moment of momentum, and another representing the energy of the system. Each point on one surface has a corresponding point on the other surface, and the point on the energy surface must always slide down hill. It is not necessarily the case that the descent should be down a line of greatest slope. Illustrations are given to show that a point on an energy surface may sometimes depart from the bottom of a furrow, or may descend a ridge on the surface. The path to be followed by the point on the energy surface depends on the nature of the tides raised in the two bodies. Thus the solution in this case is not determinate, without some further knowledge of the system.

MORE NOTES FROM KILBURN

THE gas and petroleum-engines make a fair show. The Otto silent gas-engine, however, seems still to hold its own, other constructions having, so far as one can judge from a short inspection at Kilburn, some defect or other, such as noisy working, or a dangerous-looking outside flare of the ignited gas. One striking novelty is shown in this section, namely, an invention of Mr. Dugald Clerk, whereby the gaseous mixture is lighted by a cage of platinum wire, which retains heat enough from one ignition to the next to be effective for this purpose. It is stated that 400 ignitions have been made in the cylinder of an engine of this type in one minute. There are other distinctive contrivances in this gas-engine, which, by the by, is the manufacture of Messrs. Thomson, Sterne, and Co., and altogether shows great ingenuity. One of the engines exhibited by this firm is described as a "Domestic Motor," of $\frac{1}{10}$ horse-power, costing but 15*l.*, and deriving its power from steam generated by the ignition of air and gas. Such an engine seems admirably fitted for private use in laboratories and small workshops as well as in houses.

Self-binding harvesters, in which wire is used for the automatic tying-up of the sheaves, are attracting much attention, now that millers have adopted the use of magnets, preferably electro-magnets, to separate any bits of iron wire that may happen to get mixed with the grain.

The machinery and implements employed in butter-making and cheese-making afford a striking example of the advantages resulting from the application of scientific exactness to a most useful art. The question of temperature in every operation of the dairy is now recognised as of extreme importance. The thermometer reigns supreme in the interesting tent where dairying is shown. The material, the depth, and the diameter of the pans for "setting" milk have been duly studied. Though the processes and instruments exhibited in action are few in comparison with those at the previous shows at Hamburg and other special gatherings, yet the exhibits of Mr. E. Ahlborn and of the Aylesbury Dairy Company are worth attentive study. We noted especially an ingenious butter-squeezer or presser, which removes in the most effectual way that very variable and often excessive quantity of butter-milk and water and of interstitial air which occur in ordinary butter, even when quite genuine. Not only is liability to change and decomposition much lessened by this operation, but constancy of composition is secured, and we no longer find the proportion of water in fresh butter ranging between 6 and 20 per cent.

Messrs. F. H. Atkins and Co. show some good models and examples of their water-filters and other sanitary appliances in connection with water supply. One of their contrivances is specially clever. The surfaces of filtering media of course become rapidly clogged and useless when the water supply is particularly turbid. The vertical surfaces of Atkins's cloth filters are so arranged as to be capable of rotation against a rotating cylindrical brush, set vertically, and accommodating itself perfectly to the surface to be cleansed.

An instructive section of the Kilburn Show is that devoted to hops. From a paper issued by Messrs. John

Barth and Sons, of Nuremberg, we glean some interesting data as to the hop production of the world; this firm also exhibits a diagram of hop-prices from 1798 to 1878. Some samples of hops preserved for two years or more by a process, of which the nature is kept secret, are perfect in aroma and colour. Compression, cold, and exclusion of air are elements of the process but do not suffice to account for its success. The total amount of hops grown in the world in 1878 is stated by Messrs. Barth to be—

	cwts.
England	650,000
Continental Europe	619,000
America	220,000
Total	1,489,000

Many most instructive data as well as specimens, models' and instruments, frequently showing novel applications of scientific principles, may be studied at the Kilburn Show. We had noted for remark the malt-cake exhibited on Stand 586, and the splendid collection of seeds, roots, and models shown by Sutton and Sons of Reading, but the limit of the space at our disposal preclude us from further dwelling upon this exhibition, with its perplexing but most interesting collections.

OUR ASTRONOMICAL COLUMN

THE NEW COMET (SWIFT, JUNE 20).—From observations at Strasburg by Prof. Winnecke on June 21, 26, and July 2, Dr. Küstner, one of his pupils, has computed the following elements of this comet, taking account of all the small corrections:—

Perihelion passage, 1879, April 27·3357 M.T. at Berlin.

Longitude of perihelion	42° 28′ 30″·8	Mean equinox 1879·0.
,, ascending node ...	45 33 36·6	
Inclination to ecliptic	72 59 52·5	
Log. perihelion distance	9·948935	

Motion—retrograde.

From this orbit it appears that on Tuesday next, July 15, the comet will make an exceedingly close approach to the pole of the equator; at 10h. G.M.T. its calculated position is in right ascension 15h. 20m., and declination 89° 42′, but earlier in the evening its distance from the pole may be little over 10′.

We extract the following positions from an ephemeris for Berlin midnight, communicated by Prof. Winnecke:—

1879.	Right Ascension. h. m. s.	North Declination. ° ′	Log. distance from Earth.	Log. distance from Sun.
July 11 ...	2 57 59	85 59·2	0·2209	0·1940
12 ..	2 58 6	87 4·8		
13 ...	2 57 40	88 10·3	0·2226	0·2010
14 ...	2 53 50	89 15·6		
15 ...	15 18 0	89 39·2	0·2247	0·2080
16 ...	15 6 32	88 34·3		
17 ..	15 5 33	87 29·6	0·2271	0·2148
18 ...	15 5 36	86 25·0		
19 ...	15 5 56	85 20·7	0·2300	0·2216
20 ...	15 6 25	84 17·0		

TEMPEL'S COMET, 1867 II.—In a letter addressed to *The Observatory*, communicating his observations of this comet made during the present reappearance, at Florence, Dr. Tempel remarks: "Since it will approach Jupiter nearer in the year 1882 than in the year 1870, we shall probably have difficulty in seeing it again, if we ever do so." This statement must rest upon some misconception or error of calculation. The mean daily motion at the perihelion passage in the present year would not differ materially from 593″·18 as fixed by M. Raoul Gautier, and the perihelion passage having taken place about May 6·98 G.M.T., it will appear that when the comet is next in aphelion (which is about the nearest point of approach to the orbit of Jupiter) early in May, 1882, the actual distance between the two bodies is rather more than 0·75 of the earth's mean distance from the sun, though in the actual orbit it might happen that at this point the comet and planet approach within 0·3. Neglecting the effect of perturbation in the interim, it will be found from M. Gautier's elements that the nearest approach of the comet to Jupiter during the next revolution will occur in October 1881, when their mutual distance will be rather less than 0·58. In January 1870, according to Dr. Seeliger's computation this distance was only 0·32. Although, therefore, the perturbations during the ensuing revolution may be very sensible, they will not produce so great an effect upon the elements of 1879 as to bear out Dr. Tempel's statement.

Observations of this comet have been made at the Observatory of Rio de Janeiro, where the comet was found independently by M. Cruls. The Emperor of Brazil, who appears to take a personal interest in the proceedings of his astronomical establishment, has communicated these observations to the Paris Academy of Sciences, of which his Majesty is a Corresponding Member.

THE VARIABLE-STAR PIAZZI XIII. 126.—Mr. Burnham draws attention to an interesting discovery he has made respecting this object, viz., that it is really a close double star, the components of nearly equal magnitude 6·2 and 6·5, at a central distance of 0″·48 on an angle of 80°·4 for 1879·4. Attention was first directed to its variability by Dr. Julius Schmidt, of Athens, in June, 1866. On the 6th of that month he found it 5·4m. more conspicuous than *i* Virginis, with a yellowish white light contrasting with the orange tinge of the latter star. Piazzi estimated it 6·7m. and 7m., not 8m., as given in his Catalogue; Lalande called it 6·7, Brisbane 6, Heis 6·7, and it is 7m. on Bremicker's chart; it is No. 1,342 of Lamont, who estimated it only 8m. It is worthy of note that the star occurs in the Uranometry of Al Sufi, translated by Prof. Schjellerup in 1874; it is No. 19 of the constellation Virgo in the catalogue of the Persian astronomer, and rated 5·6m. As Mr. Burnham remarks, it will be easy to determine which, if only one, of the stars is variable. The star is B.A.C. 4,531 and No. 1,244 of the new Greenwich Nine-Year Catalogue. Its position for 1880·0 is in R.A. 13h. 28m. 18s., N.P.D. 102° 35′·9.

GEOGRAPHICAL NOTES

A PRIVATE letter received at Carlscrona from the commander of the steamer *Vega* reports all on board in good health. The *Vega* left the mouth of the Lena on August 27. At first she made tolerably good progress, although she had to contend with ice and shoals. The voyage was continued to Cape Yakow, but there she was stopped for three days. The steamer got away from there on September 11, and after a difficult passage reached Cape North on the 13th, where she remained beset until the 18th. After that date the steamer could only now and then make progress on account of the ice. On September 28 the expedition attained this present position, which is situated in lat. 67° 6′, long. 173° 30′. If the *Vega* had got there two days earlier she would have reached Behring Straits. The ship is not lying in a harbour, but alongside a very low sandy shore, made fast to the ground ice. Every one was well, and there was a good supply of provisions and enough coal on board to steam 2,000 miles. One or two villages had been passed, the inhabitants of which are Tschutsches. Their complexion is tawny and their hair and eyes are black. They dress in clothes made of reindeer skin, reside in skin tents, and live on seal blubber. They are singularly amiable and obliging; the women have their faces tattooed, but the men have not. Their language is very hard to understand, but

the explorers have learnt it, and have compiled a Swedish Tschutschisk lexicon of over 300 words. There are three Tschutschisk villages in the neighbourhood of the *Vega*. The temperature in September seldom went down below 3 deg., and the lowest was 5 deg. (Centigrade). On the darkest day of the year, December 21, the sun was above the horizon. The letter was sent off from the *Vega* by a chief who was on a visit, and who lives near Anadyrsk. The explorers expected to get free about July 1, and to reach Japan about August 15.

MAJOR SERPA PINTO, the Portuguese African explorer, of whose journey we gave some account last week, arrived in London on Monday last. We understand that the Royal Geographical Society do not contemplate holding a special meeting in Major Pinto's honour, but that he will be entertained by the Earl of Northbrook, President of the Society, at a private reception on July 16, to which the leading geographers have been invited.

NEWS has arrived at Lisbon that the Portuguese explorers Capello and Ivens, who started with Major Pinto, were on the margin of the river Lucala on April 5, studying the regions crossed by the river Cubango. They had explored the Cubango from its source to the eighth parallel.

THE steamer *Jeannette*, with the Arctic Exploring expedition of the *New York Herald*, sailed on Tuesday from San Francisco for the Arctic seas, *viâ* Behring Straits. The commander is Lieut. De Long, and among the scientific staff is Mr. J. J. Collins, who expects to obtain important data in meteorology to the north of Behring Straits. The detailed plans of the expedition are purposely kept secret.

IN the current number of the *Church Missionary Intelligencer* we find an interesting account, by the Rev. C. T. Wilson, of his voyage across the Victoria Nyanza, from Uganda to Kagei, in the course of which he was able to make some important additions to our knowledge of the geography of the large group of islands at the north-western corner of the lake. He proved conclusively that Mr. Stanley is in error in placing one large island there, to which he gives the name of Sesse, as in reality there are about 150 islands. Passing down the western coast, Mr. Wilson came to the Kagera, or Kitangule River, the Alexandra Nile of Stanley. South of this, he says, the scenery underwent a great change. Previously the shore had been low, clothed with dense forest, and often fringed with beds of papyrus, while to the south the country consisted of high downs, ending in abrupt precipices, 300 or 400 feet high, which sometimes descended sheer down into the lake, and at others had a low strip of alluvial land at their base, dotted with villages. The geological formation also changed. North of the Kagera the rocks were mostly a hard conglomerate, the matrix being clay iron ore, in which quartzose pebbles were imbedded, but on the south they were clay slate, with red sandstone, the strata being inclined in a westerly direction at an angle of about 15°. Besides occasional descriptions of the country and scenery, Mr. Wilson's journal contains some interesting notes on natural history and on the customs of the people.

MR. SANFORD FLEMING, C.M.G., the engineer-in-chief, has just issued his annual report in reference to the Canadian Pacific Railway, illustrated by an interesting map of the prairie region. Mr. Fleming has endeavoured to collect all known information respecting the country within the limits of the prairie region, and, to make it easy of reference, the whole region has been subdivided into blocks, bounded by each separate parallel of latitude and longitude; the descriptions of scientific travellers and all available statements made on reliable authority are placed side by side. Much still remains to be discovered respecting large tracts of country, and Mr. Fleming suggests that the information should be obtained during the present season by careful explorations of the sections where our knowledge is deficient. On the map an attempt has been made to indicate generally the character of the soil, separating that of more or less value from tracts which are comparatively worthless.

IN the fifteenth part of the great map of Switzerland recently published at Berne, the following sheets will be found useful by English tourists in the coming season:—No. 263, Glarus; 367, Wimmis; 429, St. Maria, and 429 *bis*, Stilfser Joch (giving the Swiss portion of the Stelvio); and 526, Martigny, 529, Orsières, and 532, Grand St. Bernard (giving the whole of the Swiss side of the St. Bernard Pass). The present issue is in no respect inferior to the earlier ones, which, we have frequently pointed out, have been remarkable for their uniform excellence. When all the sheets are published, and this will occur in about twelve years' time if the present rate of issue is maintained, Switzerland will be able to boast of a map of a far higher and more useful order than is possessed by any other country in the world.

M. DE LESSEPS gave a long address at the last sitting of the Paris Geographical Society on the Panama Canal. He announced that he had entered into a contract with the Société d'Études for purchasing their rights so as to have the whole of the affair in his own hands. He stated that he had paid a deposit of 80,000*l*. to the Venezuelan Government, and his intention was to establish a public subscription of 16,000,000*l*. He thought that sum should be sufficient with the sale of land conceded by the local government, and that the canal should be finished in less than eight years. In his speech M. de Lesseps narrated a circumstance quite unknown of the career of Napoleon III. When he was a prisoner in Ham he sent one of his friends to survey the canal by Nicaragua. He was so well satisfied with the results of the inspection that he wrote a petition to the Government asking to be liberated from his life confinement, in order to devote his activity to the establishment of this great work, pledging his word of honour that he should no more meddle with politics. The petition was left unanswered. He was ready to go to Nicaragua in order to execute his long-cherished scheme, when the Revolution of 1848 broke out and changed his plans.

THE New York *Nation* records with great satisfaction the formal presentation to the U.S. Government of the invaluable collection of Indian portraits and curiosities made by the late George Catlin. This collection was, a generation ago, one of the standing attractions of London, was afterwards exhibited in Belgium, and there fell into the hands of the late Joseph Harrison, Jun., of Philadelphia, who not only helped Mr. Catlin out of his financial straits by the purchase, but intentionally preserved for his country this most remarkable record of the American aborigines. His widow has now offered it to the National Museum, where it will be duly displayed.

M. DE BRAZZA, the explorer of the Ogowé, and gold medallist of the French Geographical Society, has been summoned to Rome, where he received from the Italian Geographical Society another gold medal for his exploring work. M. de Brazza is an Italian by birth, having become French by naturalisation.

THE new *Bulletin* of the Antwerp Geographical Society contains a geographical sketch of Afghanistan, accompanied by a map, by Lieut.-Col. Adan, who appears to be the mainstay of both the Belgian societies.

THE telegraph line between Tientsin and Taku, in Northern China, was completed on May 8.

THE Japanese Government intend to connect the Loo-choo Islands with Japan by a submarine telegraph cable to Kagoshima.

MOLECULAR PHYSICS IN HIGH VACUA [1]

II.

I HAVE hitherto spoken of and illustrated these phenomena in connection with *green* phosphorescence. It does not follow, however, that the phosphorescence is always of that colour. This coloration is a property of the particular kind of glass in use in my laboratory. I have here (Fig. 7) three bulbs composed of different glass: one is uranium glass (*a*), which phosphoresces of a dark green colour; another is English glass (*b*), which phosphoresces of a blue colour; and the third (*c*) is soft German glass—of which most of the apparatus before you is made—which phosphoresces of a bright apple-green colour. It is therefore plain that this particular green phosphorescence is solely due to the glass which I am using. Were I to use English glass I should have to speak of blue phosphorescence, but I know of no glass which is equal to the German in brilliancy.

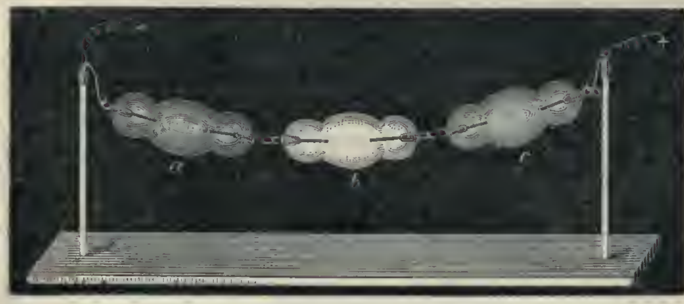


FIG. 7.

My earlier experiments were almost entirely carried on by the aid of the phosphorescence which glass takes up when it is under the influence of the electric discharge *in vacuo*; but many other substances possess this phosphorescent power, and some have it in a much higher degree than glass. For instance, here is some of the luminous sulphide of calcium prepared according to M. Ed. Becquerel's description. When it is exposed to light—even candlelight—it phosphoresces for hours with a rich blue colour. I have prepared a diagram with large letters written in this luminous sulphide; before it is exposed to the light the letters are invisible, but Mr. Gimingham has just exposed it in another room to burning magnesium, and now it is brought into the darkened theatre you will see the word "φῶς,"—*light*, a very suitable word for so beautiful a phosphorescence—shining brightly in luminous characters. The first letter, φ, shines with an orange light; it is a sulphide of calcium prepared from oyster-shells. The other letters, shining with a blue light, are sulphide of calcium prepared from precipitated carbonate of lime. Once the phosphorescence is excited the letters shine for several hours. I will put the diagram at the back, and we shall see how it lasts during the remainder of the lecture. This substance, then, is phosphorescent to light, but it is also much more strongly phosphorescent to the molecular discharge in a good vacuum, as you will see when I pass the discharge through this tube (Fig. 8). The white plate (*a*, *b*) in the centre of the tube is a sheet of mica painted over with the luminous sulphide of which the letter φ was composed in the diagram you have just seen. On connecting the poles with the coil, the mica screen glows with a strong yellowish green light, bright enough to illuminate all the apparatus near it. But there is another phenomenon to which I now desire to draw attention: on the luminous screen is a kind of distorted star-shaped figure. A little in front of the negative pole I have fixed a star (*c*) cut out in aluminium, and it is the image of this star which you see on the screen. It is evident that the rays coming from the negative pole project an image of anything that happens to be in front of it. The discharge, therefore, must come from the pole in straight lines, and does not merely permeate all parts of the tube and fill it with light as it would were the exhaustion less good. Where there is nothing in the way the rays strike the screen and produce phosphorescence, and where there is an obstacle they are obstructed by it, and a shadow is thrown on the screen. I shall have more to say about this shadow presently; I merely now wish to establish the fact that these rays driven from the negative pole produce a shadow.

FIG. 8.

I must draw your attention to an important experiment connected with these molecular rays, but unfortunately it is a very delicate one, and very difficult to show to many at once; but I hope, if you know beforehand what to look for, you will all be able to see what I wish to show. In this pear-shaped bulb (Fig. 9A) the negative pole (*a*) is at the pointed end. In the middle is a cross (*b*) cut out of sheet aluminium, so that the rays from the negative pole projected along the tube will be partly intercepted by the aluminium cross, and will project an image of it on the hemispherical end of the tube which is phosphorescent. I think you will all now see the shadow of the cross on the end of the bulb (*c*, *d*), and notice that the cross is black on a luminous ground. Now, the rays from the negative pole have been passing by the side of the aluminium cross to produce the shadow; they have been hammering and bombarding the glass till it is appreciably warm, and at the same time they have been producing another effect on that glass—they have deadened its sensibility. The glass has got tired, if I may use the expression, by the enforced phosphorescence. Some change has been produced by this bombardment which will prevent the glass from responding easily to additional excitement; but the part that the shadow has fallen on is not tired—it has not been phosphorescing at all, and is perfectly fresh; therefore if I throw this star down—I can easily do so by giving the apparatus a slight jerk, for it has been most ingeniously constructed with a hinge by Mr. Gimingham—and so allow the rays from the negative pole to fall

FIG. 9 A.

FIG. 9 B.

[1] A short-hand report of a lecture delivered at the Royal Institution on Friday, April 4, 1879. By William Crookes, F.R.S. Contributed by the author. Continued from p. 231.

uninterruptedly on to the end of the bulb, you will suddenly see the black cross (c, d, Fig. 9B) change to a luminous one (e, f), because the background is only faintly phosphorescing, whilst the part which had the black shadow on it retains its full phosphorescent power. The luminous cross is now dying out. This is a most delicate and venturous experiment, and I am fortunate in having succeeded so well, for it is one that cannot be rehearsed. After resting for a time the glass seems to partly recover its power of phosphorescing, but it is never so good as it was at first.

We have, therefore, found an important fact connected with

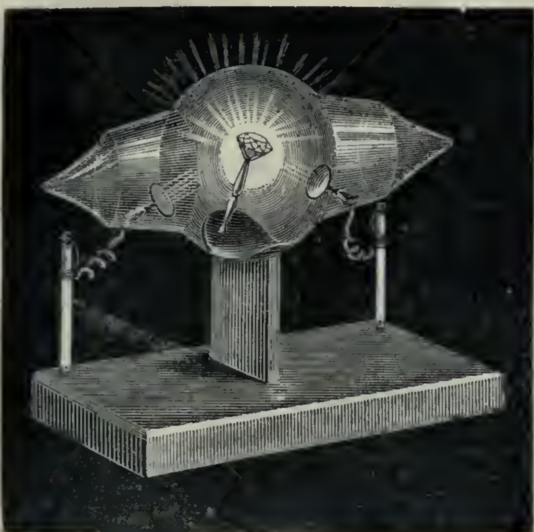


Fig. 10.

this phosphorescence. Something is projected from the negative pole which has the power of hammering away at the glass in front of it, in such a way as to cause it not only to vibrate and become temporarily luminous while the discharge is going on, but to produce an impression upon the glass which is permanent. The explanation which has gradually evolved itself from this series of experiments is this:—The exhaustion in these tubes is so high that the dark space, as I showed you at the commencement of this lecture, that extended round the negative pole, has widened out till it entirely fills the tube. By great rarefaction the mean free path has become so long that the hits in a given

Fig. 11

time may be disregarded in comparison to the misses, and the average molecule is now allowed to obey its own motions or laws without interference. The mean free path is in fact comparable to the dimensions of the vessel, and we have no longer to deal with a *continuous* portion of matter, as we should were the tubes less highly exhausted, but we must here contemplate the molecules *individually*. At first this was only a convenient working hypothesis. Long-continued experiment then raised this provisional hypothesis almost to the dignity of a theory, and now the general opinion is that this theory gives a fairly correct explanation of the facts. In these highly exhausted vessels the mean free path of the residual molecules of gas is so long that they are able to drive across from the pole to the other side of the tube with comparatively few collisions. The negatively electrified molecules of the gaseous residue in the tube therefore dash against anything that is in front, and cast shadows of obstacles just as if they were rays of light. Where they strike the glass they are stopped, and the production of light accompanies this sudden arrest of velocity.

Other substances besides English, German, and uranian glass, and Becquerel's luminous sulphides are also phosphorescent. I think, without exception, the diamond is the most sensitive substance I have yet met for ready and brilliant phosphorescence. I have here a tube, similar to those already exhibited, containing a mica screen painted with powdered diamond, and when I turn on the coil, the brilliant blue phosphorescence of the diamond can be seen, quite overpowering the green phosphorescence of the glass. Here, again, is a very curious diamond, which I was fortunate enough to meet with a short time ago. By daylight it is green, produced, I fancy, by an internal fluorescence. The diamond is mounted in the centre of this exhausted bulb (Fig. 10), and the negative discharge will be directed on it from below upwards. On darkening the theatre you see the diamond shines with as much light as a candle, phosphorescing of a bright green.

In this other bulb is a remarkable collection of crystals of diamonds, which have been lent me by Prof. Maskelyne. When I pass the discharge over them I am afraid you will only be able to see a few points of light, but if you will examine them after the lecture, you will see them phosphoresce with a most brilliant series of colours—blue, apricot, red, yellowish green, orange, and pale green.

Next to the diamond the ruby is one of the most remarkable stones for phosphorescing. In this tube (Fig. 11) is a collection of ruby pebbles, for the loan of which I am indebted to my friend Mr. Blogg, of the firm of Blogg and Martin, who placed a small sackful at my disposal. As soon as I turn on the induction spark you will see these rubies shining with a brilliant rich red colour, as if they were glowing hot. Now the ruby is nothing but crystallised alumina with a little colouring-matter, and it became of great interest to ascertain whether the artificial ruby made by M. Feil, of Paris, would glow in the same manner. I had simply to make my wants known to M. Feil, and he immediately sent me a box containing artificial rubies and crystals of alumina of all sizes, and from those I have selected the mass in this tube which I now place under the discharge: they phosphoresce of the same rich red colour as the natural ruby. It scarcely matters what colour the ruby is, to begin with. In this tube of natural rubies there are stones of all colours—the deep red ruby and the pale pink ruby. There are some so pale as to be almost colourless, and some of the highly-prized tint of pigeon's blood; but in the vacuum under the negative discharge they all phosphoresce with about the same colour.

As I have just mentioned, the ruby is crystallised alumina. In a paper published twenty years ago by Ed. Becquerel,[1] I find that he describes the appearance of alumina as glowing with a rich red colour in the phosphoroscope (an instrument by which the duration of phosphorescence in the sunlight can be examined). Here is some chemically pure precipitated alumina which I have prepared in the most careful manner. It has been heated to whiteness, and you see it glows with the rich red colour which is supposed to be characteristic of alumina. The mineral known as corundum is a colourless variety of crystallised alumina. Under the negative discharge in a vacuum, corundum phosphoresces of a rose-pink colour. There is another curious fact in which I think chemists will feel interested. The sapphire is also crystallised alumina, just the same as the ruby. The ruby has a little colouring-matter in it, giving it a red colour; the sapphire has a colouring-matter which gives it a blue colour, whilst corundum is white. I have here in a tube a very fine crystal of sapphire, and, when I pass the discharge over it, it gives alternate bands of red and green. The red we can easily identify with the glow of alumina; but what is the green? If alumina is precipitated and purified as carefully as in the case I have just mentioned, but in a somewhat different manner, it is found to glow with a rich green colour. Here are the two specimens of alumina in tubes, side by side. Chemists would say that there was no difference between one and the other; but I connect them with the induction-coil, and you see that one glows with a bright green colour, whilst the other glows with a rich red colour. Here is a fine specimen of chemically pure alumina,

[1] *Annales de Chimie et de Physique*, 3rd series, vol. lvii. p. 50, 1859.

sent me by Messrs. Hopkin and Williams; by ordinary light it is a perfectly white powder. It is just possible that the rich fire of the ruby, which has caused it to be so prized, may be due not entirely to the colouring-matter, but to its wonderful power of phosphorescing with a deep red colour, not only under the electric discharge in a vacuum, but whenever exposed to a strong light.

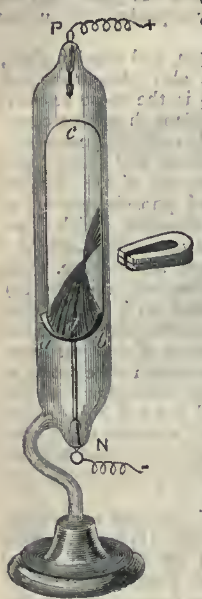


FIG. 12.

The spectrum of the red light emitted by all these varieties of alumina—the ruby, corundum, or artificially precipitated alumina—is the same as described by Becquerel twenty years ago. There is one intense red line, a little below the fixed line B in the spectrum, having a wave-length of about 6895. There is a continuous spectrum beginning at about B, and a few fainter lines beyond it, but they are so faint in comparison with this red line that they may be neglected. This line may be called the characteristic line of alumina.

I now pass on to another fact connected with this negative discharge. Here is a tube (Fig. 12) with a negative pole (a, b) in the form of a hemi-cylinder, similar to the one you have already seen (Fig. 3), but in this case I receive the rays on a phosphorescent screen (c, d). See how brilliantly the lines of discharge shine out, and how intensely the focal point is illuminated; it lights the whole table. Now I bring a small magnet near, and move it to and fro; the rays obey the magnetic force, and the focus bends one way and the other as the magnet passes it. I can show this magnetic action a little more definitely. Here is a long glass tube (Fig. 13), very highly exhausted, with a negative pole at one end (a) and a long phosphorescent screen (b, c) down the centre of the tube. In front of the negative pole is a plate of mica (b, d) with a hole (e) in it,

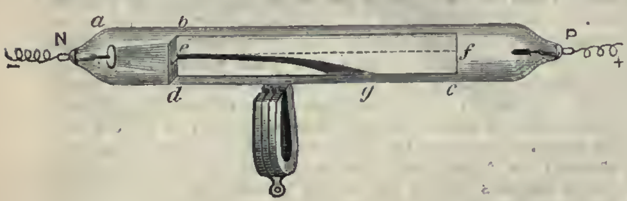


FIG. 13.

and the result is that when I turn on the current, a line of phosphorescent light (e, f) is projected along the whole length of the tube. I now place beneath the tube a powerful horse-shoe magnet: see how the line of light becomes curved under the

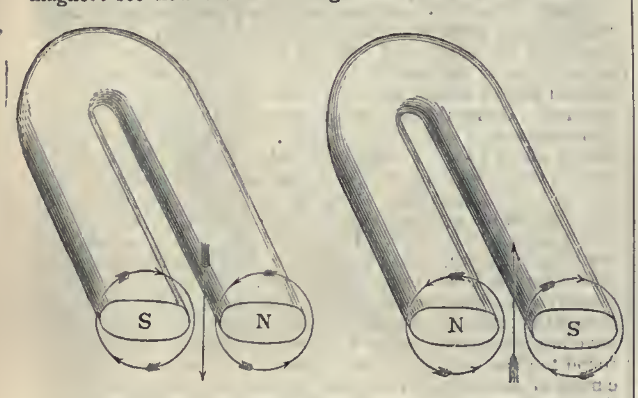


FIG. 14.

magnetic influence (e, g), waving about like a flexible wand as I move the magnet up and down. The action of the magnet can be understood by reference to this diagram (Fig. 14). The north pole gives the ray of molecules a spiral twist one way, and the south pole twists it the other way; the two poles side by side compel the ray to move in a straight line up or down, along a plane at right angles to the plane of the magnet and a line joining its poles.

Now it is of great interest to ascertain whether the law governing the magnetic deflection of the trajectory of the molecules is the same as has been found to hold good at a lower vacuum. The former experiment was with a very high vacuum. This is a tube with a low vacuum (Fig. 15). On passing the induction spark it passes as a narrow line of violet light joining the two poles. Underneath I have a powerful electro-magnet. I make contact with the magnet, and the line of light dips in the centre towards the magnet. I reverse the poles, and the line is driven up to the top of the tube. Notice the difference between the two phenomena. Here the action is temporary. The dip takes place under the magnetic influence; the line of discharge then rises, and pursues its path to the positive pole. In the high exhaustion, however, after the ray of light had dipped to the magnet it did not recover itself, but continued its path in the altered direction.

During these experiments another property of this molecular discharge has made itself very evident, although I have not yet drawn attention to it. The glass gets very warm where the green phosphorescence is strongest. The molecular focus on the tube, which we have just seen (Fig. 12) would be intensely hot, and I have prepared an apparatus by which this heat at the focus can be intensified and rendered visible to all present. This small tube (a) (Fig. 16) is furnished with a negative pole in the form of a cup (b). The rays will therefore be projected to a focus in the middle of the tube (Fig. 17, a). At the side of the tube is a small electro-magnet, which I can set in action by touching a key, and the focus is then drawn to the side of the glass tube (Fig. 17, b). To show the first action of the heat I have coated the tube with wax. I will put the apparatus in front of the electric lantern (d), and throw a magnified image of the tube on the screen. The coil is now at work, and the focus of molecular rays is projected along the tube. I turn the magnetism on, and draw the focus on the side of the glass. The first thing you see

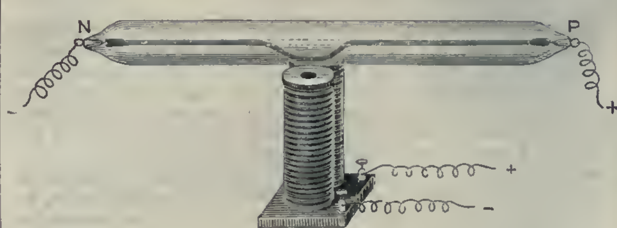


FIG. 15.

is a small circular patch melted in the coating of wax. The glass soon begins to disintegrate, and cracks are shooting star-wise from the centre of heat. The glass is softening. Now the atmospheric pressure forces it in, and now it melts. A hole (c) is perforated in the middle, the air rushes in, and the experiment is at an end.

Instead of drawing the focus to the side of the glass with a magnet, I will take another tube (Fig. 18), and allow the focus from the cup-shaped negative pole (a) to play on a piece of platinum wire (b) which is supported in the centre of the bulb. The platinum wire not only gets white-hot, but you can see sparks coming from it on all sides, showing that it is actually melting.

Here is another tube, but instead of platinum I have put in the focus that beautiful alloy of platinum and iridium which Mr. Matthey has brought to such perfection, and I think that I shall succeed in even melting that. I first turn on the induction-coil slightly, so as not to bring out its full power. The focus is now playing on the iridio-platinum, raising it to a white heat. I bring a small magnet near, and you see I can deflect the focus of heat just as I did the luminous focus in the other tube. By shifting the magnet I can drive the focus up and down, or draw it completely away from the metal, and render it non-luminous. I withdraw the magnet, and let the molecules have full play again; the metal is now white-hot. I increase the intensity of the spark. The metal glows with almost insupportable brilliancy, and at last melts.

There is still another property of this molecular discharge, and it is this:—You have seen that the molecules are driven

violently from the negative pole. If I place something in front of these molecules, they show the force of impact by the heat which is produced. Can I make this mechanical action evident in a more direct way? Nothing is simpler. I have only to put some easily moving object in the line of discharge in order to get a powerful mechanical action. Mr. Gimingham, with great

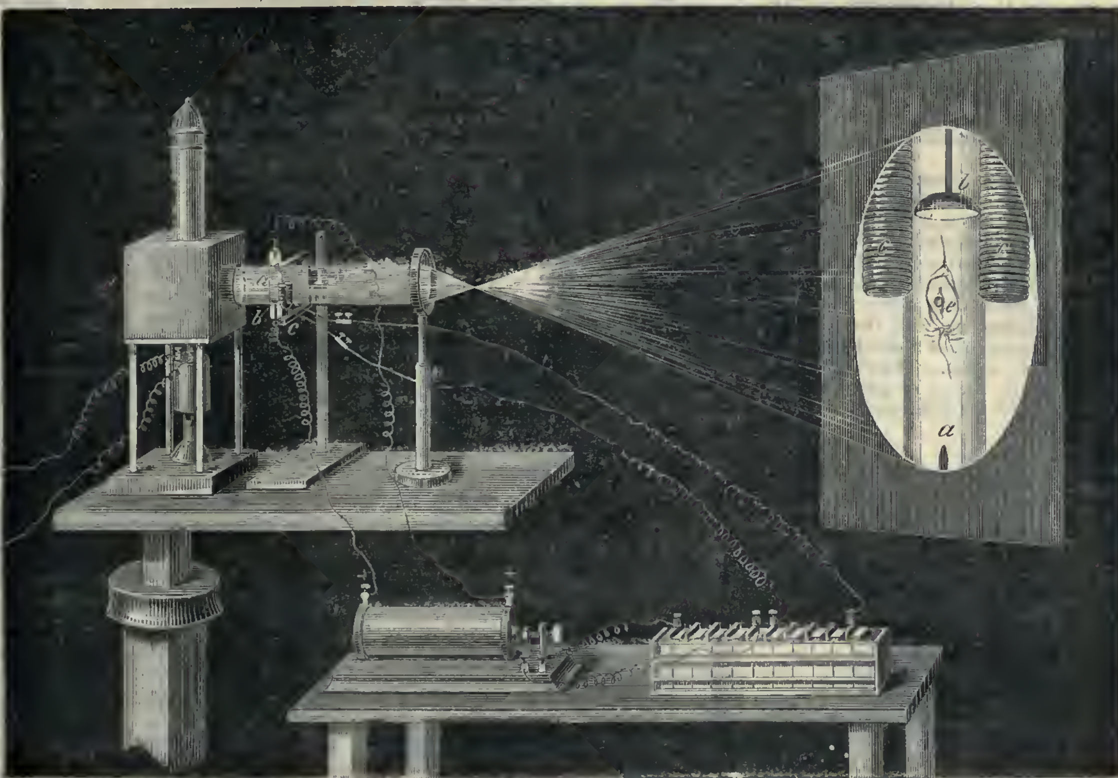


FIG. 16.

skill, has constructed a piece of apparatus which I will presently put in the electric lantern, so that all will be able to see its action. But first I will explain the construction by means of this diagram (Fig. 19). The negative pole (a, b) is in the form of a very shallow cup. In front of the cup is a mica screen

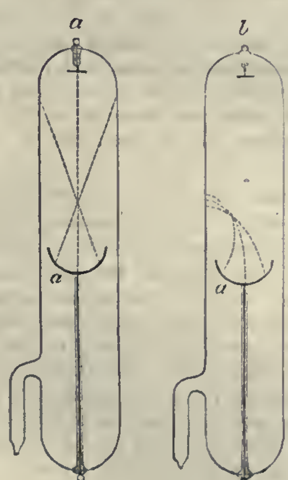


FIG. 17.

(c, a), wide enough to intercept nearly all the molecular rays coming from the negative pole. Behind this screen is a mica wheel (e, f) with a series of vanes, making a sort of paddle-wheel of it. So arranged, the molecular stream from the pole a b will nearly all be cut off from the wheel, and what escapes over and under the screen will hit the vanes equally, and will not produce any movement. I now put a magnet, g, over the tube, so as to

FIG. 18.

deflect the stream over or under the obstacle c d, and the result will be rapid motion in one or the other direction, according to

the way the magnet is turned. I now throw the image of the apparatus on the screen. The spiral lines painted on the wheel show which way it turns. I arrange the magnet to draw the molecular stream so as to beat against the upper vanes, and the wheel revolves rapidly, as if it were an over-shot water-wheel. I now turn the magnet so as to drive the molecular stream underneath; the wheel slackens speed, stops, and then begins to rotate the other way, as if it were an under-shot water-wheel. This can be repeated as often as I like to reverse the position of the magnet, the change of rotation of the wheel showing immediately the way the molecular stream is deflected.

This experiment illustrates the last of the phenomena which time allows me to bring before you, attending the passage of the induction spark through a highly exhausted atmosphere. It will now be naturally asked, What have we learned from the phenomena described and exhibited, and from the explanations that have been proposed? We find in these phenomena confirmation of the modern views of matter and energy. The facts elicited are in harmony with the theory that matter is not continuous but composed of a prodigious number of minute particles, not in mutual contact. The facts also are in full accordance with the kinetic theory of gases—to which I have already referred—and with the conception of heat as a particular kind of energy, expressing itself as a rapid vibratory motion of the particles of matter. This alone would be a lesson of no small value. In science every law, every generalisation, however well established, must constantly be submitted to the ordeal of a comparison with newly-discovered phenomena; and a theory may be pronounced triumphant when it is found to harmonise with and to account for facts which, when it was propounded, were still unrecognised or unexplained.

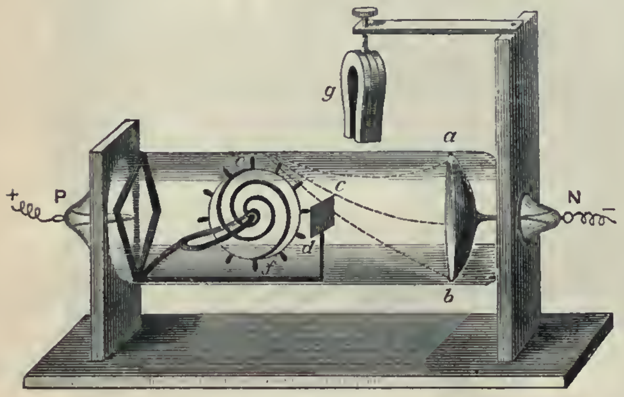


FIG. 19.

But the experiments have shown us more than this: we have been enabled to contemplate matter in a condition hitherto unknown—in a fourth state—as far removed from that of gas as gas is from liquid, where the well-known properties of gases and elastic fluids almost disappear, whilst in their stead are revealed attributes previously masked and unsuspected. In this ultra-gaseous state of matter phenomena are perceived which in the mere gaseous condition are as impossible as in liquids or solids.

I admit that between the gaseous and the ultra-gaseous state there can be traced no sharp boundary; the one merges imperceptibly into the other. It is true also that we cannot see or handle matter in this novel phase. Nor can human or any other kind of organic life conceivable to us penetrate into regions where such ultra-gaseous matter may be supposed to exist. Nevertheless, we are able to observe it and experiment on it, legitimately arguing from the seen to the unseen.

Of the practical applications that may arise out of these researches, it would now be premature to speak. It is rarely given to the discoverer of new facts and new laws to witness their immediate utilisation. The ancients showed a perhaps unconscious sagacity when they selected the olive, one of the slowest growing trees, as the symbol of Minerva, the goddess of Arts and Industry. Nevertheless, I hold that all careful honest research will ultimately, even though in an indirect manner, draw after it, as Bacon said, "whole troops of practical applications."

NOTES

A MEETING of the Executive Committee having charge of the whole arrangements for the approaching visit of the British Association to Sheffield was held the other day. In connection with the Guide Book it was reported that contributions were arranged from Prof. Green, Mr. Arthur Jackson, Mr. [illegible]. Prittain, Mr. G. R. Vine, Mr. J. D. Leader, and others. It is proposed to issue the guide books at 1*s*. each, and they will contain scientific and other information suitable for visitors and residents. Dr. Sorby stated that a number of eminent men from foreign countries, including representatives from Germany, Italy, France, Belgium, the United States, and other parts of the world, had accepted invitations to take part in the meetings in Sheffield. These distinguished visitors will represent different branches of science; and from France the British Association is this year to be honoured, after the lapse of a long period, with the presence of the President of the Academy of Sciences, M. Daubrée. The Mayor (Ald. Ward) is to give a banquet to a number of distinguished guests in the banqueting hall of the Cutlers' Company on Saturday, August 23. A reception is to be given by the Master Cutler and Cutlers' Company, which will take place in the Cutlers' Hall on Thursday, August 21. A *soirée* is to be arranged by the local committee for the Tuesday following, also in the Cutlers' Hall. The arrangements for the excursions are being actively carried out. The Duke of Devonshire has invited a limited number of Members of the Association to a luncheon at Chatsworth. Earl Manners has invited a number of excursionists to luncheon at Thoresby, with the additional offer that they should be driven round the forest and park afterwards. Sir Joseph Whitworth has offered hospitality to a party of excursionists visiting Darley Dale and the district, and a similar offer has been made by Mr. F. C. Armitage, as regards a party exploring Arborlowe. The Rev. A. W. Hamilton-Gell invites a number of excursionists to Stanton-in-Peak, with the promise that they should see Router Rocks and other places of interest. Sir John Lubbock is to be asked to give an address at Arborlowe on the interesting Druidical remains there to be seen. Generally the arrangements were reported to be in a very satisfactory state.

SOME weeks since we stated that a committee had been formed for the purpose of raising a fund for the benefit of the widow and family of the late Mr. W. G. Valentin, F.C.S. We understand that many of the friends and former pupils of this well-known chemist have responded with liberality, but as there may be others whom previous appeals have not reached, we have pleasure in stating that subscriptions will still be received by the hon. treasurer of the fund, Mr. F. W. Bayly, Royal Mint, E.

THE success which attended Mr. Tegetmeier's reprint of Boddaert's "Table des Planches Enluminées," and Mr. Dresser's reproduction of Eversmann's Addenda to Pallas's "Zoographia Rosso-Asiatica," has suggested the organisation of a "Willoughby Society for the Reprinting of scarce Ornithological Works," which has accordingly been formed, with every prospect of success. The annual subscription is 1*l*., and no copies of the works reprinted will be sold. The selection of the works to be reprinted by the Society has been intrusted to a committee consisting of the past and present editors of *The Ibis*, and Tunstall's "Ornithologia Britannica" will be the first work reproduced. Particulars may be obtained from the secretary, F. D. Godman, Esq., 10, Chandos Street, Cavendish Square, W.

THE death is announced of Dr. Johann Karl Friedrich Rosenkranz, Professor of Philosophy at Koenigsberg University. Dr. Rosenkranz published a number of philosophical treatises, and was well known through his excellent edition of the works of Immanuel Kant. He died at the age of seventy-four on June 14.

THE monument of the late eminent botanist, Prof. Alexander Braun, was unveiled on June 17 at the Botanical Gardens of Berlin. The granite pedestal is by Prof. Adler, the bust of the deceased, which is said to be an excellent likeness, by the well-known sculptor Prof. Schaper.

ACCORDING to the resolution passed at the last International Congress of Americanists at Luxemburg in 1877, the city of Brussels will be the meeting-place for this year's (third) congress. It will be held from September 23-26 under the protectorate of the King of the Belgians and the honorary presidency of the Count of Flanders. We have before stated the objects of the Congress, which will again be occupied by the consideration and discussion of a series of questions relating to the history, archæology, anthropology, ethnography, linguistics, and palæography of North and South America.

PROF. VIRCHOW, Dr. Schliemann's companion and coadjutor in the latest excavations in the Troad, has written to the eminent Homeric archæologist, informing him of a concurrence of geological opinion at Berlin in the conclusion that all the building stones, fragments of which the professor brought home from Hissarlik, are of fresh-water formation. This conclusion is thought to be decisive against those who affirm the impossibility of identifying Hissarlik with the Homeric Troy, on the ground that at the time of the great epic war the site must have been covered by the sea.

IN the Paris Academy of Sciences M. Dausse has been elected a Corresponding Member in the Section of Mechanics, in succession to the late General Didion.

THE French Minister of Fine Arts has placed at the disposition of the War Office fourteen cups of Sèvres china to be offered in competition to the societies of carrier-pigeon breeders.

THE *Times* Paris correspondent states that Dr. Krauss, at a scientific meeting at Stuttgart a few days ago, referred to the recent swarms of the *Vanessa cardui* butterfly. A like phenomenon occurred in Piedmont in 1741, 1826, and 1857. This year a swarm passed through Turin on June 2, through Switzerland from the 2nd to the 9th, Alsace, France, and Spain from the 5th to the 10th, and Würtemburg from the 11th to the 21st. Prof. Eimer, of Tübingen, found that eighteen out of nineteen specimens were females full of eggs, and he attributes the march to the search for a place to deposit their eggs; a march directed by their keen scent. Caterpillars have already been found on thistles in the districts visited, and a large number may be looked for.

THE thirty-sixth annual congress of the British Archæological Association is to be begun at Great Yarmouth on August 11, and continue until the 20th, the last three days, commencing on Monday, August 18, being passed at Norwich. Lord Waveney will deliver an inaugural address at the Town Hall, Great Yarmouth, as president of the meeting, on Monday, August 11, and the following days up to Saturday the 16th will be dedicated to a variety of interesting excursions.

IN connection with the celebration of the fiftieth anniversary of the Paris Central School of Arts and Manufactures, the *Gazzetta d'Italia* states that the meeting of engineers connected with the Florentine branch was held on Sunday, and that a banquet was given by the president, Commendatore Prof. Vegni. After dinner those present visited the Workshop Galileo, in which so much is being done for the resuscitation of mechanical art in Florence, with no aid either from Government or the Municipality. Over the door of the workshop is a clock so ingeniously constructed that it has gone now for fourteen months with a loss of only five seconds. A chronograph was exhibited capable of registering the thousandth part of a second, and applicable to the measurement of the velocity of projectiles; a cathetometer capable of measuring heights to the 1,200th of a millimetre, a new electric machine by induction, and a most efficient pneumatic machine, the invention of the eminent Padre Cecchi.

WE daresay most of our readers will be pleased at the result of the motion by Mr. S. Lloyd in the House of Commons, on Tuesday, in favour of appointing a Minister of Commerce and Agriculture. The motion was agreed to by a fair majority, among which were members of both sides of the House. This is a step in the right direction.

THE Giffard captive balloon has begun its series of night ascents by an experimental trip, which was made on June 30 with great success. The court of the Tuileries was lighted by ten Jablochkoff lamps. It is proposed to carry an electric lamp on the car if the sixty portable Bunsen elements which are in preparation can be carried without inconveniencing passengers. Captive ballooning is making its way in foreign lands. A captive balloon is being fitted up in one of the places of resort round New York; the balance for registering the levitation has been constructed in Philadelphia. It can register accurately 10,000 pounds, and is built for sustaining 25,000.

THE Paris Exhibition of Sciences Applied to Industry will be opened on the 24th inst. The preparations are being made with great activity in the Palais de l'Industrie. M. Jules Simon, the President of the Council, and M. Nicol, the Director, had an interview, on June 29, with the President of the Republic, to suggest a series of measures intended to promote the success of the exhibition.

MR. F. W. MOORE, eldest son of the late Dr. Moore, has been appointed Curator of the Botanic Gardens, Glasnevin, Dublin. Mr. Moore has been for some time curator of the College Botanic Garden, Dublin.

A SELECT Committee of the House of Commons, of which Mr. A. Pell was chairman, have concluded their consideration of the Bill promoted by the Liverpool Corporation, to give power to adopt and supply for public and private purposes lighting by electricity. The committee had intimated their decision to pass the Bill if amendments were made in the preamble, the effect of which would be to limit the power of the Corporation to making a scientific experiment, and not allow them to make it a commercial undertaking for purposes of profit, or to compete with the gas company. Amendments were proposed by the Corporation in this direction, and the committee passed the Bill.

IT is stated that the Council of India, despairing of obtaining the repeatedly asked-for assistance of the Imperial Government towards defraying the cost of the India Museum, have decided to break it up and to distribute the collections between the British and South Kensington Museums and Kew.

FROM the report on the forests and plantations in the Island of Mauritius for 1878 we learn that many of the trees which were introduced from India a few years ago have thriven beyond expectation and have in some instances already reached the size of useful timber trees. Among those which have done best are mahogany, teak, and eucalyptus. The last named (*E. calophyllus*) is found to grow with remarkable vigour, and produces fertile seed at a very early age. The severe hurricanes which sweep over the island commit great devastation among the plantations of eucalyptus and other fast-growing trees, and the Government this season intend to plant out a large number of the young gum trees to be grown as large as bushes. In this form they are expected to be able to withstand the force of the wind, and form a screen for the protection of young plantations of timber trees.

On Saturday the Geologists' Association have an excursion to Tunbridge Wells and Crowborough Beacon. On Monday, July 21, and five following days the same society intend to have an outing in the neighbourhood of Ledbury; the Malvern Hills and Woolhope Valley being included in the programme.

In the *Journal de Physique* for June M. Cornu gives an account of his spectroscope designed for observation of ultra-violet radiations. It resembles the common two-prism spectroscope, except in the materials employed, the ordinary materials, crown-glass and flint-glass, absorbing ultra-violet radiations at least from the line O, *i.e.*, from wave-length = 340 millionths of a millimetre. M. Cornu uses quartz for the prisms, and the objective of the collimator (as also of the telescope) is made achromatic; it consists of a biconvex lens of quartz and a divergent plane concave lens of Iceland spar, both cut perpendicularly to the optic axis.

Phosphoric acid has the property of hindering the precipitation of albumen by tannin, but is without action on gelatine. M. Ador lately had the curiosity to try its effect in the tanning of skins, starting with the idea that the pores of skin would remain more open and that the solution of tannin would thus more rapidly coagulate the gelatinous substances, within the skin, producing a more rapid tanning. His experiments, both in the laboratory and on a large scale, are described in the *Moniteur Scientifique* for June. They show that the anticipated effect was realised, and that it allows of the use of a much stronger juice; but there is danger of a loss of weight if the liquids be agitated, by reason of coagulation, outside of the tissues, of a certain quantity of albuminoid principles dissolved by the phosphoric acid, and removed from the skin. He recommends manufacturers to experiment further in the same direction.

M. Robin, the anatomist, who is the only member of the Academy of Sciences who is also in the French Senate, has proposed a bill for instituting an inquiry into the means of increasing the fish production of the French rivers.

In the aëronautical ascent made at Rouen, referred to in our last number, the altitude was 1,200, not 12,000, metres.

The New York correspondent of the *Daily News* telegraphs that Mr. Edison states that since the patents for his electric light were issued he has improved the standard meter for measuring the electricity fed to the burners, and has perfected a method of insulating and conveying the wires from the generating stations to the houses of the consumers. He is satisfied that this generator cannot be improved. 94 per cent., it is said, of horse-power is set free in the electric current, and 82 is delivered in the wire outside of the machine. Eight-ninths of the current is used for the light, and one-ninth is lost in the machine. Mr. Edison's latest experiments give seven gas jets per horse-power, and he expects to increase the number to ten. He says the platinum burner is a settled thing; but, so long as he sees his way to getting more light cut of the horse-power, he will continue his experiments. He expects to perfect his experiments within four weeks.

A catastrophe similar to the one which was happily averted at Teplitz is now feared at the well-known watering-place of Baden, near Vienna. An official investigation committee has been formed, comprising several members of the Geologische Reichsanstalt, and has already begun examining the springs threatened with exhaustion.

We continue to receive the numbers of the *Revista de Canarias*, to which we referred some weeks since. We trust it will meet with the support it deserves, as it is evidently making honest attempts to spread a knowledge and cultivate a taste for science among the inhabitants of the favoured islands. The last number, June 8, contains an article on the Palæontology of the Canaries, by Miguel M. y La-Roche; one on the Hygiene of the Potato, by Lorenzo Lapuyade; another on Primary Instruction in the Canaries, by Juan de la Puerta Causeco.

A violent earthquake is reported from Agram on June 21 at 8.55 A.M., which was repeated on the 22nd at 1.42 A.M. On both occasions the phenomenon consisted of several shocks proceeding in the direction from west to east.

We learn from a Queensland paper that Mr. Walter Hill has been sent on a tour of inspection to Great Sandy, or Fraser, Island, a large irregular-shaped island lying off the coast to the north of the twenty-sixth parallel of south latitude, where it is reported that some valuable timbers flourish, notably the kaurie pine. For some time past the curator of the Botanical Gardens has been giving his attention to the propagation of some of the most valuable timbers indigenous to the colony, and at one place he has formed a nursery of red cedar trees, in which 30,000 plants have been successfully reared and are now all in a flourishing condition. It is believed that a part of Mr. Hill's mission to Fraser Island is to look for suitable sites for arboriculture, with the view of utilising the large number of red cedar plants he has reared. The red cedar takes from sixty to one hundred years to attain its best development, and this care for distant posterity is probably due to thoughtfulness on the part of the authorities who view with alarm the wholesale devastation and waste of the timber which from time to time take place in the colony. It is said that there are yet plenty of cedar trees in the Queensland forests, but quite recently several million feet of this timber were swept out to sea in consequence of a fresh in the Mossman, Daintree, and Johnston rivers.

Careful statistics have been taken in Paris of the cases of rabies observed in 1878. The total number of cases reported to the Prefecture has been 440 dogs, 68 bitches, and 3 cats. Out of these 511 cases 390 were biting rabies. The number of wounds inflicted on persons was 103, and the number of deaths 30—about 1 to 3. This is the same proportion as resulted from previous inquiries. Almost all these cases have been reported from Paris out of a population of 2,000,000. The number of animals which have been bitten by mad dogs is 342 dogs and 24 cats. 234 animals were taken to the veterinary school of Alfort either for autopsy or for inspection.

It is stated that in consequence of the auriferous indications in the Cooktown district, the Queensland Government will offer a reward of 5,000*l*. to stimulate the discovery of a gold-field rich enough to pay the cost of working.

Part V. just issued of the past *Transactions* of the Leicester Literary and Philosophical Society contains the papers read from June, 1850, to June, 1855.

The additions to the Zoological Society's Gardens during the past week include a Grand Galago (*Galago crassicaudata*) from East Africa, presented by Mr. W. Jenkins; a Grivet Monkey (*Cercopithecus griseo-viridis*) from North-East Africa, presented by Mr. R. M. Courage; a Rhesus Monkey (*Macacus erythræus*) from India, presented by Mr. Jas. Bartle; a Puma (*Felis concolor*) from Buenos Ayres, presented by Lord Lilford, F.Z.S.; a Blue-eyed Cockatoo (*Cacatua ophthalmica*) from the Solomon Islands, presented by Lieut.-Col. Arbuthnot, 14th Hussars; a Common Boa (*Boa constrictor*) from South America, presented by Dr. A. Stradling; a Black-faced Spider Monkey (*Ateles ater*), three Red-billed Tree Ducks (*Dendrocygna autumnalis*) from South America, a Collared Fruit Bat (*Cynonycteris collaris*), captured in the Red Sea, two White Storks (*Ciconia alba*), a Common Whimbrel (*Numenius phæopus*), European, a Reticulated Python (*Python reticulatus*) from Manilla, purchased; an Axis Deer (*Cervus axis*), born in the Gardens.

THE GENESIS AND MIGRATIONS OF PLANTS

SUCH is the title of a paper, in a recent *Princetown Review*, by Prof. Dawson, whose intention in writing has been to place clearly and concisely before his readers the facts, as he interprets them, connected with the fossil floras of the Arctic and North American regions. The necessity to do so became apparent, he states, from the time that Heer described the cretaceous[1] Vancouver Island flora as miocene, and yet more when the Devonian Bear Island flora was described as carboniferous. The present publication, however, was immediately induced by Saporta's very remarkable essay on the northern origin of plant species and Hooker's latest anniversary address to the Royal Society.

The Professor commences the present essay by recalling that Asa Gray had, as early as 1867, suggested that the related floras of North America and Eastern Asia had a common northern origin; and that in 1872 he further developed this theory, embracing in it the work of Heer and Lesquereux on the tertiary floras.

He then proceeds:—

"Between 1860 and 1870 the writer was engaged in working out all that could be learned of the Devonian plants of Eastern America, the oldest known flora of any richness, and which consists almost exclusively of gigantic, and to us grotesque, representatives of the club mosses, ferns, and mares'-tales, with some trees allied to the cycads and pines. In this pursuit nearly all the more important localities were visited, and access was had to the large collections of Prof. Hall and Prof. Newberry in New York and Ohio, and to those made in the remarkable plant-bearing beds of New Brunswick by Messrs. Matthew and Hartt. In the progress of these researches, which developed an unexpectedly rich assemblage of species, the northern origin of this old flora seemed to be established by its earlier culmination in the north-east, in connection with the growth of the American land to the southward, which took place after the great upper silurian subsidence, by elevations beginning in the north while those portions of the continent to the south-west still remained under the sea.

"When, in 1870, the labours of those ten years were brought before the Royal Society of London in the Bakerian lecture of that year, and in a memoir illustrating no less than one hundred and twenty-five species of plants older than the great carboniferous system, these deductions were stated in connection with the conclusions of Hall, Logan, and Dana, as to the distributions of sediment along the north-east side of the American continent, and the anticipation was hazarded that the oldest Palæozoic floras would be discovered to the north of Newfoundland. Mention was also made of the apparent earlier and more opious birth of the Devonian flora in America than in Europe, a fact which is itself connected with the greater northward extension of this continent."

The memoir was not published by the Royal Society, and some little disappointment, he says, was thereby occasioned, but it appeared shortly after, although in a less perfect form.[2]

In the next place he contends that Heer was in error in supposing that the Bear Island plants are of carboniferous age, and attributes to Heer the responsibility of having led other European geologists to infer that the whole group of beds from the Hamilton to the Chemung were carboniferous, although they underlie the oldest beds of that stage and contain a Devonian fauna. He continues:—

"In 1872 I addressed a note to the Geological Society of London on the subject of the so-called 'Ursa stage' of Heer showing that though it contained some forms not known at so early a date in temperate Europe, it was clearly Devonian when tested by North American standards; but that in this high latitude, in which, for reasons stated in the report above referred to, I believed the Devonian plants to have originated, there might be an intermixture of the two floras. But such a mixed group should in that latitude be referred to a lower horizon than if found in temperate regions. In the discussion of these papers, both Sir C. Lyell and Dr. Carruthers argued that the Bear Island flora is truly Devonian.

"Passing over the comparatively poor flora of the earlier mesozoic, consisting largely of cycads, pines, and ferns, and as yet little known in the Arctic, though represented, according to Heer, by the supposed Jurassic flora of Cape Boheman, we find, especially at Komé and Atané in Greenland, an interesting occurrence of those earliest precursors of the truly modern forms of plants which appear in the Cretaceous, the period of the English Chalk and of the New Jersey greenlands. There are two plant-groups of this age in Greenland; one, that of Komé, consists almost entirely of ferns, cycads, and pines, and is of decidedly mesozoic aspect. This is called lower cretaceous. The other, that of Atané, holds remains of many modern temperate genera, as *Populus*, *Myrica*, *Ficus*, *Sassafras*, and *Magnolia*. This is regarded as upper cretaceous. Resting upon these upper cretaceous beds, without the intervention of any other formation,[1] are beds rich in plants of much more modern appearance, and referred by Heer to the miocene period, a reference warranted by comparison with the tertian plants of Europe, but, as we shall see, not with those of America. Still farther north this so-called miocene assemblage of plants appears in Spitzbergen and Grinnell Land; but there, owing to the predominence of trees allied to the spruces, it has a decidedly more boreal character than in Greenland, as might be anticipated from its nearer approach to the pole.[2]

"If now we turn to the cretaceons and tertiary floras of Western America, as described by Lesquereux, Newberry, and others, we find in the lowest cretaceous rocks there known—those of the Dakota group—which may be in the lower part of the middle cretaceous, a series of plants[3] essentially similar to those of the so-called upper cretaceous of Greenland. They occur in beds indicating land and fresh-water conditions as prevalent at the time over great areas of the interior of America. But overlying this plant-bearing formation we have an oceanic limestone (the Niobrara), corresponding in many respects to the European chalk, and extending far north into the British territory,[4] indicating that the land of the lower cretaceous was replaced by a vast Mediterranean Sea, filled with warm water from the equatorial currents, and not invaded by cold waters from the north. This is succeeded by thick upper cretaceous deposits of clay and sandstone, with marine remains, though very sparsely distributed; and these show that further subsidence or denudation in the north had opened a way for the arctic currents, killing out the warm-water animals of the Niobrara group, and filling up the Mediterranean of that period. Of the flora of these upper cretaceous periods, which must have been very long, we know nothing in the interior regions; but on the coast of British Columbia we have the remarkable cretaceous coal-field of Vancouver's Island, which holds the remains of plants of modern genera, and indeed of almost as modern aspect as those of the so-called miocene of Greenland. They indicate, however, a warmer climate as then prevalent on the Pacific coast, and in this respect correspond with a peculiar transition flora, intermediate between the cretaceous and eocene or earliest tertiary of the interior regions, and which is described by Lesquereux as the lower lignitic.

"Immediately above these upper cretaceous beds, we have the great lignite tertiary of the west—the Laramie group of recent American reports—abounding in fossil plants, at one time regarded as miocene, but now known to be lower eocene, though extending upward toward the miocene age.[5] These beds, with their characteristic plants, have been traced into the British territory north of the forty-ninth parallel, and it has been shown that their fossils are identical with those of the McKenzie River Valley, described by Heer as miocene, and probably also with those of Alaska, referred to the same age.[6] Now this truly eocene flora of the temperate and northern parts of America has so many species in common with that called miocene in Greenland, that its identity can scarcely be doubted. These facts have led to scepticism as to the miocene age of the upper plant-bearing beds of Greenland, and more especially Mr. J. Starkie Gardner has ably argued, from comparison with the eocene flora of England and other considerations, that they are really of that earlier date.[7]

"In looking at this question, we may fairly assume that no

[1] Lesquereux considers this flora to be eocene.

[2] "Fossil Plants of the Devonian and Upper Silurian Formations of Canada," Pp. 92, twenty plates. (Montreal, 1871.)

[1] Nordenskiöld, "Expedition to Greenland," *Geological Magazine*, 1872.

[2] Yet even here the Bald Cypress (*Taxodium distichum*), or a tree nearly allied to it, is found, though this species is now limited to the Southern States. Fielden and De Rance, *Journal* of Geological Society, 1878.

[3] Lesquereux. "Report on Cretaceous Flora."

[4] G. M. Dawson, "Report on Forty-ninth Parallel."

[5] Lesquereux's "Tertiary Flora"; White, On the "Laramie Group"; Stevenson, "Geological Relations of Lignitic Groups," Am. Phil. Soc., June, 1875.

[6] G. M. Dawson, "Report on the Geology of the Forty-ninth Parallel," where full details on these points may be found.

[7] *Nature*, vol. xviii. p. 124.

conceivable conditions of climate could permit the vegetation of the neighbourhood of Disco in Greenland to be identical with that of Colorado and Missouri, at a time when little difference of level existed in the two regions. Either the southern flora migrated north in consequence of a greater amelioration of climate, or the northern flora moved southward as the climate became colder. The same argument, as Gardner has ably shown, applies to the similarity of the tertiary plants of temperate Europe to those of Greenland. If Greenland required a temperature of about 50°, as Heer calculates, to maintain its 'miocene' flora, the temperature of England must have been at least 70°, and that of the South-western States still warmer."

The author then speculates upon the former migrations of plants, and although he does not assign, like Saporta, an unvarying north and south direction, he believes that in most instances these were the lines upon which they moved. He also places a cold period between the middle cretaceous (upper cretaceous of Atané, Heer) and the lower eocene (Greenland miocene, Heer), which had not been previously noticed.

We would here remark that there is, in like manner, evidence of a cool period at the base of the English eocene. Either one relatively cool period existed at the close of the upper cretaceous of America, and another at the base of the English eocene, or else too great an age is assigned to the American series. The latter supposition is supported by Lesquereux's researches. The beds showing the more temperate conditions on the two continents are either contemporaneous or else a geological interval exists between them. Much more evidence is required before the correlation of the American and European cretaceous and tertiary rocks can be finally determined, and it is satisfactory to know that Dr. Hayden is collecting evidence on the subject.

The lower eocene flora of Greenland "established itself in Greenland, and probably all around the arctic circle, in the warm period of the earliest eocene, and as the climate of the northern hemisphere became gradually reduced from that time to the end of the pliocene, it marched on over both continents to the southward, chased behind by the modern arctic flora, and eventually by the frost and snow of the glacial age. This history may admit of correction in details; but so far as present knowledge extends it is in the main not far from the truth."

Space does not permit us to reprint the pages devoted to the various theories that have been put forward to account for former vicissitudes of climate. While allowing due weight to Croll's ingenious and well known theories, and to the larger proportion in the past of carbonic dioxide, he nevertheless is convinced of the sufficiency of the Lyellian theory of former altered distribution of land and water to account for all the facts hitherto observed.

The author conceives, however, that in some recent publications the Lyellian theory has been misconceived, but this is not exactly the case. What he here terms the Lyellian theory was really shared by many contemporary writers on physical geography, and is, that when land surfaces are aggregated round the equator and the polar oceans are wide and open, a hot period results, and that the reverse distribution induces cold, thus giving to land the heating power. The more recent theory is a modification of this, requiring masses of water, warmed under the equator, to circulate, unchilled by polar currents, and the polar oceans to be dry or else more or less closed in by land. This view he adopts.

"If North Greenland were submerged, and low land reaching to the south terminated at Disco, and if from any cause either the cold currents of Baffin's Bay were arrested, or additional warm water thrown into the North Atlantic by the Gulf Stream, there is nothing to prevent a mean temperature of 45° Fahrenheit from prevailing at Disco; and the estimate ordinarily formed of the requirements of its extinct floras is 50°,[1] which is probably above rather than below the actual temperature required."

Professor Dawson believes that to whatever causes the cold periods may be traced, they drove the warm temperate flora to the south, unless protected in insular spots by warm currents, and that on the return of warmth the plants would return northward.

"If, however, our modern flora is thus one that has returned from the south, this would account for its poverty in species as compared with those of the early tertiary. Groups of plants descending from the north have been rich and varied. Returning from the south they are like the shattered remains of a beaten army. This at least has been the case with such retreating floras as those of the lower carboniferous, the permian, and the Jurassic, and possibly that of the lower eocene of Europe."

The great stretch north and south of the American continent favoured these migrations, and "is also connected with the interesting fact that, when new floras are entering from the arctic regions, they appear earlier in America than in Europe; and that in times when old floras are retreating from the south, old genera and species linger longer in America. Thus, in the Devonian and cretaceous new forms of those periods appear in America long before they are recognized in Europe, and in the modern epoch forms that would be regarded in Europe as miocene still exist. Much confusion in reasoning as to the geological ages of the fossil floras has arisen from want of attention to this circumstance."

[1] Heer. See also papers by Professor Haughton and by Gardner in *Nature* for 1878.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

In reply to a question in the House of Lords the other day the Duke of Richmond and Gordon stated that it was only in 1875 that it was decided to add agriculture to the syllabus of the Science and Art Department. At the first examination in May, 1876, there were only 150 candidates. By the following year 72 classes had been established, and the number of candidates rose to 800. In 1878 the classes had increased to 91, and the candidates for examination to 1,265, and this year the number of classes had reached 147; the number of persons under instruction was 2,839, of whom 2,193 came up for examination. Prof. Tanner reported that the results of the examination were very satisfactory. Fifty selected teachers, it was stated, had been brought up to London to undergo a course of training at the expense of the department.

The two silver medals which are annually given by the Royal Geographical Society to those candidates whom the examiners deem to be most proficient in geography at the Cambridge Local Examinations have this year been awarded as follows:—Physical Geography, J. R. Davis; Political Geography, Miss Helen Jones. This, we believe, is the first occasion on which a medal has been awarded to a lady.

The professors of the Paris Museum of Natural History having to present to the Minister of Public Instruction the names of two candidates for the lectureship of Comparative Anatomy, vacated by the death of M. Paul Gervais, have selected M. Georges Pouchet for their first candidate, and M. Jourdain for the second. The appointment of the former is quite certain.

The number of students at the German Universities during the winter semester 1878-9 was 18,770. Berlin stands at the top of the list with 3,213, while Rostock had only 161.

SOCIETIES AND ACADEMIES

London

Royal Society, June 19.—"Relations between the Atomic Weights and certain Physical Properties (Melting and Boiling Points and Heats of Formation) of Elements and Compounds." By Thomas Carnelly, D.Sc., Assistant Lecturer on Chemistry in Owens College, Manchester. Communicated by Prof. H. E. Roscoe, F.R.S.

Anthropological Institute, June 24.—Mr. John Evans, F.R.S., vice-president, in the chair.—The election of the following new Members was announced:—Mr. F. Du Cane Godman, F.L.S., F.Z.S., and Mr. Percy Cotterill Wheeler, Bengal Civil Service.—Prof. W. H. Flower, F.R.S., read a paper on the osteology of the natives of the Andaman Islands. There are few people whose physical characters offer a more interesting subject for investigation to the anthropologist than the native inhabitants of the Andaman Islands. Purity of type, due to freedom from mixture with other races for an extremely long period, owing to their isolated position and their inveterate hostility to all intruders on their shores, and exemplified in the uniformity of their physical characters, is to be found among them, perhaps in a more complete degree than in any other group of mankind. The type, moreover, is an extremely peculiar one, presenting a combination of characters not found in any race of which we have at present materials for a satisfactory comparison. It is, indeed, probable that the more or less mixed and now scattered fragments of Negrito population, found in the interior of various islands of the Indo-Malayan Archipelago, and even upon some parts of the

mainland of Asia, may have been derived from the same stock, but the special interest of the Andamanese consists in the fact that they alone of the diminutive black, woolly-haired people, occupy the whole of the small islands, on which their ancestors have dwelt from time immemorial, or rather did so occupy them until the coming upon them of the English in 1857. The materials upon which the observations contained in the memoir are based, are far more complete than any wh'ch have hitherto been brought together, consisting of nineteen skeletons and nearly thirty skulls. The skeletons indicate an average height of 4 feet 9 inches in the males, and 4 feet 6 inches in the females, thus showing that they belong to some of the smallest of known races. The skulls all belong to what is known as the brachycephalic or round-headed type, having an average cephalic index (or proportion of breadth to length) of 82. The forehead is broad and flat, without any projection over the orbits. The nose is narrow and the jaws less prominent than in the other black races. The proportionate length of the various bones of the limbs differ greatly from the European standard, but resemble those of the negro. With the Australian the Andamanese have very little affinity, the smooth hair of the former entirely separating them, independently of cranial characters, as dolichocephaly (or long-headedness) strongly pronounced brow ridges, low orbital index, wide nasal aperture, great prognathism, &c. It is to the other woolly-haired races that we must naturally turn in endeavouring to find their nearest relatives. The Papuans and inhabitants of the Melanesian Islands differ from them greatly in their principal cranial characters, especially in the great height and narrowness of the skull. The Tasmanians had wider heads, but their facial characters were more like those of the Australians, and therefore widely different from the Andamanese. The African negroes, again, are almost all dolichocephalic, and as a general rule are extremely prognathous, and strongly platyrhine or broad-nosed. Many of them, however, have the smooth brow and round orbits seen in the Andamanese, and not generally met with in the true oceanic negroes. The natives of the Andaman Islands, with whom may probably be associated the less known Aetas of the Philippines, the Semangs of the Malay Peninsula, thus constitute a race apart, to which the name Negrito may properly be applied. At first sight, they appear in their craniological characters to present little affinity to either of the other woolly-haired races, but it is probable that they represent a small or infantile type of the same primary group, as nearly all the characters by which they differ from the other negroes—the smaller size, smoother, and more globular heads, absence of supraorbital prominences, rounder orbits, and less projecting jaws, are those which we find in the younger individuals of a species, as compared with the older, or in the smaller species of a natural group as compared with the larger. It is very possible, but this is purely hypothetical, that the Andamanese, whose geographical position is almost midway between either extremes of the range of the woolly-haired races, may be the unchanged or little-modified representatives of a primitive type, from which the African negroes on the one hand, and the Oceanic negroes on the other, have taken their origin, and hence everything connected with their history or structure becomes of the greatest interest to the anthropologists.—The following papers were also read:—On palæolithic implements from the Valley of the Brent, by Mr. Worthington G. Smith; and Portstewart and other flint factories of the north of Ireland, by W. J. Knowles.

Physical Society, June 21.—An extra meeting of this Society was held on the above date at Cooper's Hill Indian Engineering College, on the invitation of Col. Chesney, R.E., Lord Rosse occupying the chair.—Prof. Unwin, of the College, read a paper on experiments relating to the friction of fluids on solid surfaces against which they rub. It has long been known that a board dragged through water suffers a resistance varying in some way as the square of the velocity; that a stream takes a uniform motion at such a velocity that the component of the weight of the water down its inclined bed is balanced by the frictional drag on the bottom. The fluid in the neighbourhood of the stream is known not to move as a solid mass, the centre moving faster than the sides, and the different fluid layers rub against each other. The adhesion of the fluid to the solid against which it moves also gives rise to a sliding or rubbing action. Our knowledge of the subject has hitherto been gained from observations on pipes, streams, and from the experiments of the late Mr. Froude with a plank of wood drawn through the water of a canal. It is desirable to have a set of laboratory experiments, however, in which the conditions can be varied more than can be done by such methods, and for this purpose the author had designed a special apparatus. In Mr. Froude's experiments there was a practically unlimited mass of water and a definitely limited extent of solid surface, and his results are not free from certain anomalies. The author thought it might be instructive to try the other case of a limited mass of water and a virtually unlimited surface. A disk in rotation gives such a surface. In some respects a cylinder would (as suggested by Prof. Ayrton) be the simplest to treat theoretically, but there are experimental difficulties in its way. The apparatus of the author consists of a metal disk rotated on a vertical axis in a vessel of water, and the problem is to determine its resistance to rotation, since this will be equivalent to the water-friction upon it. Within the outer vessel is placed a thin copper chamber, the diameter of which is unalterable, but the depth is variable at pleasure. The disk is placed concentrically inside this chamber, where there are two cheese-shaped masses of water, one above and one below the disk, which are dragged into rotation next the disk, and retarded next the sides of the pan. The couple required to rotate the disks is equal to the couple exerted by the disk or the fluid when the motion is uniform; hence the tendency of the chamber to rotate is measured, by suspending the latter from three wires in a manner similar to the bifilar suspension of magnets. An index marks whether it rotates or not on a graduated scale; and a weight suspended by a cord measures the force required to keep the index at zero. Let M be the moment of the frictional resistance of the disk, N the number of revolutions per second. Then $M = C N^x$, where C and X are constants. The author has obtained a number of results which are, however, not yet ready for publication. He mentioned, however, that a rough cast-iron disk has a frictional resistance almost exactly as the square of the velocity, whereas a turned brass disk gave a value of x decidedly less than 2. The resistance is a little greater when the mass of water is larger. These results were calculated for a speed of 10 feet per second. The author hopes to try the effect of temperature, &c., on fluid friction and viscous as well as thin fluids. Prof. Unwin also exhibited a piece of apparatus with which he hopes to study the stress of rivetted plates under shear, by means of elastic substances such as caoutchouc. He purposes to stretch the caoutchouc and photograph the appearance of stress rivetted lines upon it.—Lieut. G. S. Clark, R.E., explained the process invented by Prof. McLeod and himself for determining the absolute pitch of tuning-forks. Unlike other methods this is an optical one, and consists in arranging the tuning-fork to vibrate in front of a rotating drum whose periphery is marked with dots or fine lines at equal intervals. A microscope was arranged to comprise in its field of view the edge of the fork and several of the intervals on the drum, so that when the drum was rotated at a rate which made the speed of an interval equal to the period of the fork, a set of prominences or waves, in width equal to an interval, were visible; the body of the wave being caused by the advance and recession of the fork in its vibration. The rotation of the drum was regulated by an air-regulator devised by Prof. Unwin, the observer himself quickening or slowing the drum so as to keep the prominences steady. The time was beat by an electric clock designed by Prof. McLeod. An aniline glass pen was used to mark the beginning and end of the period of observation on the drum. A counter was also employed to give the number of revolutions. The pen and counter were actuated by electricity through the medium of a key. In these experiments a König fork giving 256 vibrations per second correct at 16°·1 C., was tested, and found to give 256·2966 vibrations per second. Frequent bowing did not alter the phase. Fixing the fork rigidly, as in a vice, did so. The temperature coefficient for König's forks (·00011 for each degree Centigrade) was confirmed by these experiments. Forks of different octaves were compared; audible beats could be counted, and modifications of Lesage's figures seen. This optical method is preferable to audible ones, because of its independence of the ear and the fact that nothing is attached to the fork itself. Prof. Guthrie inquired if the periods of the forks had been found to alter through use or magnetisation. The author said that he had not yet tested these points. Prof. McLeod instanced an old König fork which was correct at 16°·1 C., requiring now a temperature of 25° C. to make it so. Lord Rosse suggested the use of the regulators employed with equatorial clocks to keep the rotation of the drum steady. Capt. Abney inquired if a difference of vibration had been detected between the beginning and end of a series of observations. None had been certainly observed.—Prof. Macleod then described an electric clock used in the foregoing experiments. The zinc and

steel compensating pendulum moved by its own gravity, but at each beat made and broke a battery circuit by means of two bent springs, one on either side. The current passing through an electro-magnet, detained a bent lever until the pendulum swung to the other contact. By this contrivance time was marked. Prof. Macleod found that platinum contacts frequently stuck together in these experiments; but this defect had been cured by the use of a liquid shunt of dilute sulphuric acid, which destroyed the extra current. This remedy had been suggested to him by Lord Rayleigh. Prof. Macleod demonstrated the complete success of this device, which acts as well as a condenser shunt. He had also observed a curious effect with these liquid shunts, which as yet he could not explain. Two shunts having the same acid in both were employed, one shunting the extra current from four Daniell cells, and one that from two Daniell cells. The first showed evolution of H and O gas, the platinum electrodes being unaffected. The second showed no evolution of gas, but one platinum plate was dissolved away and deposited in a black powder on the other. He also exhibited a new cell formed of zinc and mercury plates, with zincic-iodide solution and mercurous chloride salt. Red iodide of mercury is formed at the negative electrode. The E M F is $\frac{7}{10}$ths of a Daniell cell, but the internal resistance very low and the cell very constant; while there is no local action. Prof. Guthrie suggested that the extra current was really a succession of sparks; the platinum might be carried bodily over from one electrode to the other. Mr. F. H. Varley stated that Mr. F. Higgins had observed a similar effect with carbon electrodes in a voltameter, one carbon falling away into a fine powder, and due perhaps to the disintegrating action of liberated gases. He had also himself seen a platinum wire in contact with a carbon one eaten thin and drawn into very fine silky pens, while the carbon was stained blue, although the current passing was of low tension. Mr. Chandler Roberts suggested that perhaps a hydride of platinum was formed in the case mentioned by Prof. Macleod. Prof. Guthrie suggested experiments with fluorescent liquid shunts in the dark.—Mr. J. W. Clark then described some experiments on the surface tension of sulphurous anhydride, sealed in a capillary tube within a second tube, containing the same substance. He found that at low temperatures the level of the liquid is lower in the narrow than in the wide tube. As the temperature rises the meniscus in the narrow tube descends till about 156° Fahr.; it is level with that of the wider tube, both surfaces being slightly concave. Above this temperature the surfaces become plane, then convex, the level in the wide tube becoming higher than that in the narrow one. These experiments are being continued, and Mr. Clark's other results will be communicated to the Society later on.—Prof. Guthrie proposed a vote of thanks to Col. Chesney.

PARIS

Academy of Sciences, June 30.—M. Daubrée in the chair.—The following papers were read:—On the chemical constitution of alkaline amalgams, by M. Berthelot. He shows that the relative affinities of the two alkaline metals for oxygen are inverted in their amalgams. This explains the singular anomaly discovered by MM. Kraut and Topp, viz., the displacement of potassium in dissolved potash by amalgamated sodium, producing the crystallised amalgam $Hg_{24}K$. The displacement is the necessary consequence of the greater loss of energy undergone by the potassium in the formation of the amalgam.—On a peculiarity of an experiment of Gay Lussac and Thenard, by M. Debray. The experiment is that in which hydrated potash or soda in vapour are passed over an excess of well cleaned iron in a highly heated gun-barrel. Hydrogen and vapour of potassium or sodium are liberated, the oxygen being fixed in part of the iron. Gay Lussac and Thenard noticed, without explaining, that the fixation was chiefly on the metal in the part exterior to the furnace, and therefore less hot. This M. Debray attributes to the presence of vapour of the metal and of hydrogen remaining in the apparatus. From experiments by M. Sainte-Claire Deville, it may be deduced that if a mass of iron incompletely oxidised, and having its different parts at variable temperatures, be in a more or less dense atmosphere of hydrogen, the oxygen will quit the hotter parts where it was originally fixed, and go to the cooler. M. Debray illustrates the phenomena by an experiment.—Spectral examination of ytterbine, by M. Lecoq de Boisbaudran. He gives the approximate position and form of the bands, grouped chiefly between the solar lines D and F, of which the spectrum is composed.—M. Dausse was elected Correspondent in Mechanics in room of the late General Didion.—On atmospheric waves, by M. Bouquet de la Grye. This relates to the results of some 15,000 observations of barometric height, and direction and velocity of the winds, at Brest. The numbers given as showing the maximum influence of solar and lunar action prove the greatness of this action and the impossibility of making serious predictions of weather before the atmospheric laws dependent thereon have been studied.—On the nature of the soil of the Isthmus of Gabes and the Chotts, by M. Roudaire. He gives a summary of his observations (some of which have been formerly referred to). His collections contain about 300 plant species and 120 animal, several new; he has also some 500 geological specimens, results of twenty-two borings, daily observations of atmospheric pressure, temperature, hygrometry, the wind, &c.—On Stokes's law; reply to M. Becquerel, by M. Lamansky.—On the dissociation of sulphydrate of ammonium, by MM. Engel and Moitessier. They prove that sulphuretted hydrogen and ammonia do not combine in equal volumes at 50°, and that the supposed vapour of sulphydrate of ammonium is merely a mixture of two gases.—Action of phtalic anhydride on naphtaline in presence of chloride of aluminium, by MM. Ador and Crafts.—On the ashes and lava of the recent eruption of Etna, by M. Cossa. The very fine blackish-grey ash is formed of fragments of crystals of triclinic felspar, augite, small grains of magnetite, and a large number of variously coloured splinters of glass. The lava is formed in great part of large crystals of triclinic felspar disseminated porphyrically in a microcrystalline magma, formed of small crystals of the same felspar, augite, magnetite, and a little greyish vitreous matter. The phenomena (in M. Cossa's opinion) tell against the hypothesis of pre-existence in the solid state of the crystalline elements in lava vomited by volcanoes.—New researches on development of the embryonal sac in angiospermous phanerogams, by M. Vesque.—On a new substance of the epidermis, and on the process of keratinisation of the epidermic coat, by M. Ranvier. The new substance, found in the form of drops in cells of the epidermis, and rapidly colourable red with carmine, he calls *eleidine;* it plays an important *rôle* in keratinisation of the epidermis.—On the structure of broad ligaments, by M. Guérin.—On the state of glandular cells of the submaxillary after prolonged excitation of the chorda tympani, by MM. Arloing and Renaut. He concludes that these cells have a proper individuality, and are not embryonal forms of muciparous cells.—Forage in shocks of sheaves, by M. Duplessis. Green forage may be transformed into hay, in rainy weather, by arranging in shocks, and this transformation takes place more surely and economically than by the old method in the same circumstances.—On the ancient roads of the Sahara, by M. Berlioux. Some old inscriptions have been discovered by the German expedition in the Libyan Desert, on the route the author had indicated as probably a Roman road at one time.

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THURSDAY, JULY 17, 1879

RECENT PUBLICATIONS ON GALILEO'S TRIAL BEFORE THE INQUISITION

Galileo Galilei and the Roman Curia, from Authentic Sources. By Karl von Gebler. Translated with the Sanction of the Author by Mrs. George Sturge. (London: C. Kegan Paul and Co., 1879.)

Der Process Galilei's und die Jesuiten. Von Dr. F. H. Reusch, Professor an der Universität in Bonn. (Bonn, 1879.)

La Question de Galilée: les Faits et les Conséquences. Par Henri de l'Epinois. (Paris et Bruxelles, 1878.)

Encore Galilée! Polémique—Histoire—Philosophie. Par le P. Eugène Desjardins, de la Compagnie de Jésus. Seconde Édition. (Paris, 1877.)

IN presenting us with an English translation of Karl v. Gebler's "Galileo," Mrs. Sturge has conferred an unquestionable boon on those who, without caring to pursue the subject in Continental publications, wish to obtain a fairly complete view of the relations between the Florentine astronomer and the authorities of the Roman Church, as seen in the light of the most recent researches. The original,[1] which appeared in 1876, was chiefly remarkable for its happy selection of just so much documentary and collaterally illustrative matter as sufficed to render the whole drama of Galileo's conflict for the Copernican theory, in its most authentic form, at once accessible to every educated German reader. The English public are now, thanks to Mrs. Sturge's labours, placed in an equally, indeed an even more, favourable position. To explain how this has come about, it is necessary to refer for a moment to circumstances which preceded the early and lamented death of the German author in September 1878.

One of the topics discussed in the greatest detail by v. Gebler in 1876 was a particular order of the Inquisition purporting to have been delivered to Galileo in 1616 by the mouth of its Commissary-General. He then held very decidedly—following the footsteps of Wohlwill in Germany, and of Gherardi in Italy—that the order in question never reached Galileo at all, and that a minute in the Vatican manuscript, purporting to report its delivery, was a forgery effected for the most sinister objects in 1633. A subsequent controversy with Prof. Berti determined v. Gebler to apply for permission to examine the original manuscript record of the trial preserved in the Vatican Archives, in order to satisfy himself by personal inspection as to the disputed point. His application, powerfully supported by the Austrian embassy at Rome, was acceded to by the Papal authorities. As the result of an investigation made in the summer of 1877, he declared himself satisfied that the disputed entry in the trial record was *not*, as he had till then maintained, a forgery, but a genuine document of the year 1616. In spite, however, of this frankly avowed change of opinion, he firmly adhered to his previously expressed convictions that Galileo had not been served with the order of the Inquisition, and that therefore the minute asserting the contrary, though genuine, stated what was inherently false. It is obvious that, had the author been called upon to prepare a second edition of his "Galileo," his changed attitude towards the forgery-question would have compelled him to effect considerable alterations in many passages of the work. This revision was, however, not destined for his hands. A predisposition to lung-disease had been fatally aggravated by ten weeks of the very heaviest literary labour, undertaken in preparing his admirably complete edition of the Vatican MS., and passed in the dangerous atmosphere of a Roman summer. He returned home greatly reduced, but had still strength to make, a few months later, a short tour among the principal cities and places historically connected with the life and memory of Galileo. On September 7, 1878, he succumbed to his incurable malady, at the early age of twenty-eight.

The reader will now be in a position to see that the preparation of an English version of v. Gebler's work presupposed a revision such as its author, had he lived to effect it, must necessarily have carried out. This task has been most judiciously performed by Mrs. Sturge, though on her title-page she modestly abstains from taking credit for it. In addition to making such alterations as the author's change of view directly entailed, she has brought the work abreast of the very latest research, and supplied in an appendix a short series of documents exactly co-extensive with the wants of the general reader as distinguished from the specialist or professed historical student. The work of translation is done with much fidelity and in a way to show that Mrs. Sturge has gone far beyond the tether of the mere translator and grasped the inner significance of the events which she had to clothe in an English dress. Her volume is not immoderately large, and its print and general appearance do credit to its enterprising publishers. While, however, this important contribution to Galileo-literature in England is thus entitled to a very hearty welcome, it contains a few minor blemishes which it may be well in conclusion just to indicate.

The translation is occasionally verbally inaccurate Thus *die Acten des Processes* is systematically rendered the "Acts" instead of the "Records" of the Trial. At p. 8 we read of Galileo's "intellectual" (instead of 'clever' or 'ingenious' = *geistreich*) "treatment of physics." On p. 46 "*in seinem betreffenden Schreiben*" is translated "in his striking letter," where the real meaning is of course "in his letter referred to." At p. 272 it is said that Galileo had better beware of the Holy Office, whereas in the original the word *Jene* shows that *other* persons were meant. "*Ex suppositione*" is translated "as a conjecture" (p. 203), where "assumption" is obviously the proper equivalent.

In the English version of a Latin document (p. 78) the original of which is given in a note on the same page, the corrupt reading "Rottz" displaces the right reading "Rose." Further, "Augustino" and "Mongardo" appear as nominative cases, and "*dioc. Politianeñ*" is rendered diocese of "Politianeti" instead of "Montepulciano."

The title of Prof. Reusch's volume might easily lead one to expect some further elucidation of the oft-mooted question to what extent the measures taken against Galileo were instigated by the Jesuits. It turns out,

[1] Reviewed in NATURE, vol. xiv. p. 226.

however, that nineteenth, not seventeenth, century Jesuits are the main objects of the writer's animadversion. Certain Fathers of that Order have recently made elaborate attempts to whitewash and even decorate the Inquisition at the expense of its illustrious victim, and it is to these that their well-known "Old Catholic" opponent now calls hostile attention. The attack on these writers, however, occupies only a comparatively small portion of the work, and will be best noticed further on. Its bulk is made up of a laboriously complete collection of historical matter bearing on Galileo's trial, and of detailed disquisitions on every question of importance flowing from that perennial source of interminable controversy. Prof. Reusch claims for his book that it should be regarded not as "merely an improved and enlarged edition of that of v. Gebler," but also as containing a detailed examination of a question which the young Austrian writer was "not theologian enough thoroughly to discuss," viz., "What do we learn from the condemnation of the Copernican doctrine in 1616, and from the sentence on Galileo in 1633, in reference to the authority claimed at Rome for the decision of theological and quasi-theological controversies?" It will thus be seen that the author's main object is practically an anti-infallibilist polemic, into the merits of which it would be improper to enter here. In the few criticisms now to be made on his work I shall limit myself strictly to its historical and literary side.

The volume before us—a closely-printed quarto of 482 pages—is assuredly entitled to be called an "enlarged" edition of v. Gebler's work, but its author's claim to have also "improved" on the labours of his predecessor seems, in one important respect, open to serious question. Von Gebler, it will be remembered, while conceding the genuineness of a particular document, stoutly maintained to the last that *its contents were essentially false*. Reusch argues that the document is genuine, and *its contents true*. His view on this crucial question is therefore opposed to that of the writer whose work he is "improving," and its substitution for the position deliberately reaffirmed by v. Gebler cannot be recognised as a process of "improvement" until the formidable series of arguments in support of that position constructed by Wohlwill and Gherardi, and very fully set out in the pages of v. Gebler himself, have been essentially invalidated. Into the details of our author's elaborate attempt to supply such an invalidation space forbids me to enter. I can only express my personal opinion that it is based on unsupported conjectures more inherently improbable than the closely concatenated inferences which he labours to overthrow. In spite, moreover, of his zealous and conscientious efforts in the collection of illustrative materials from every possible quarter, the result is marked by a diffuseness and a want of orderly arrangement which are only too likely to exhaust an ordinary reader's whole stock of patience long before he reaches the conclusions to which this formidably extensive pile is designed to lead up. Prof. Reusch's reasoning itself is somewhat ponderous, and shows but little trace of the eager perspicuity which lends such coercive force to the arguments of his chief opponent, Wohlwill.

The most telling part of his book undoubtedly is his attack on the modern Jesuit commentators already referred to, in which our author's hearty detestation of crooked literary practices comes out with refreshing vigour of expression. He points with indignation to their systematic efforts to aggravate the dark spots in Galileo's private life, the weak points of his character, and other like matters of little or no bearing on the main issue; he reprehends their attempts to minimise or explain away the harsh dealings of the Holy Office with its illustrious prisoner; he condemns their inveterate habit of backing up untenable positions by misleading citations and even downright garbling. As an instance of the astounding length to which these advocates are prepared to go in the defence of their *thesis* he quotes the statement of Grisar to the effect that Galileo's judges "could not have had the faintest suspicion" that he would be unable to give a conscientious assent to their decision. When the same writer goes on to justify this assertion on the ground of the humiliating expressions of self-abnegation used by the unhappy prisoner during his examination under the paralysing influence of fear, it is certainly, as Reusch himself remarks, "difficult, even for a Jesuit, to write anything more Jesuitical."

It is much to be regretted that in anything coming from the pen of one who has done such good service to the cause of Galileo literature as has M. Henri de l'Epinois, arguments should be found presenting even a superficial resemblance to those so justly denounced by Prof. Reusch. Certainly, however, his latest popularly written little account of Galileo's trial contains statements and inferences of a kind to make one hope that they may have been admitted into its pages on trust from other writers without passing the author's personal scrutiny. I must justify this remark by reference to particular instances.

One of the strongest pieces of evidence on the side of Wohlwill and his school is a certificate written by Cardinal Bellarmine in 1616, stating that only the declaration of the Index Congregation with regard to the Copernican doctrine had been communicated to Galileo. The whole force of the document depends on the word *only*. M. de l'Epinois, in giving an account of the hostile argument founded on this document (p. 227), summarises its contents so as to omit this pivot-word altogether.

On the following page, Bellarmine's having used words which by implication excluded the delivery of a stringent personal injunction to Galileo is toned down into his having "said nothing about" this injunction.

On p. 229 the fact of an unsuccessful search having been made in the Vatican archives for a particular missing document is described as resting only on vague report (*dit on*), whereas since the appearance of v. Gebler's edition of the trial-record in 1877, we know that the fact was officially vouched for by the Cardinal Secretary of State himself.

In endeavouring to prove (p. 250) that the Commissary of the Inquisition did actually deliver his injunction in 1616, M. de l'Epinois says that it never occurred to Galileo to deny the fact in the course of the proceedings of 1633. He lays stress on the admission of the accused that Dominican monks were present during the interview with Bellarmine, one of whom may have been the Commissary, but omits to mention Galileo's affirmation that they said nothing to him, and that he did not know who they were. He emphasises the fact that the written defence of the accused admitted the reception of an order

from the Inquisition, but passes over in silence Galileo's perfectly explicit declaration that the order in question had come to him through no other person than Cardinal Bellarmine. Any one who knows how different are the parts assigned in the Vatican manuscript to the Cardinal and to the Commissary will see at a glance the serious nature of this last omission.

On p. 231 an argument is advanced, the futility of which one would have thought must have been obvious to the possessor of the most elementary knowledge about inquisitional suits in general, and that of Galileo in particular. M. de l'Epinois expresses astonishment that Galileo, if he was really conscious of having been condemned on a trumped-up charge, should not have left behind him, in letters to his friends, some protest against the abominable act of fraud of which he had been the victim.

Now, in the first place, it was the regular practice of the Inquisition to exact from those who appeared at its bar an oath of absolute silence, under pain of excommunication in case of contravention, as to everything which had occurred within the sacred tribunal. We know from the Vatican MS. that this precaution was taken in the case of Galileo. Further, the sentence of 1633 menaced him with being treated as a relapsed heretic (*i.e.* burned alive) if he should venture to treat of his condemned opinion of the earth's motion in any manner whatever. Lest it should be supposed that this was a piece of mere formality, the Inquisitor of Florence, during Galileo's subsequent practical imprisonment in his own villa at Arcetri, threatened him in the most unmistakable language with immediate incarceration in the actual dungeons of the Roman Inquisition if he should dare to propagate in conversation the Copernican doctrine.

It requires, then, little prophetic gift to foresee what would have befallen Galileo had he been detected setting in circulation a charge of the blackest fraud against the supreme tribunal of the Inquisition. His silence on the subject can cause those who believe in the reality of this fraud no astonishment whatever. The only surprise they are likely to experience is that a writer so exceptionally acquainted with the details of Galileo's case as is M. de l'Epinois, should have esteemed an argument of this kind worthy of a place in his pages.

I cannot think that M. de l'Epinois is more successful in setting up a positive theory of his own than he is in demolishing that of Wohlwill. He maintains a thesis favourable to the Roman authorities, but it is based on efforts to explain away, or assert away, palpable contradictions, and on gratuitous and mutually destructive assumptions. In short, his whole treatment of the issue essentially in dispute is both superficial and unsatisfactory.

Father Desjardins, of the Society of Jesus, tells the world that, inspired with sacred boldness (*de saintes audaces*), he has torn from the hands of the Church's enemies a weapon of which they had made sinister use, by restoring to the incident of Galileo so long travestied by ignorance and bad faith, its veritable physiognomy. His preface concludes with the following piece of advice to such of his readers as may be disposed to criticise the acts and institutions of the Roman Church in this or any other case:—

"Approve everything without hesitation, and soon philosophic examination will reward your confidence by presenting to you a complete demonstration of all these things!"

Such a maxim is so little likely to find favour with readers of NATURE that I shall trouble them no further with the magniloquent Jesuit's production which is as superficial, arrogant, and inconclusive as its pompous exordium would lead one to expect.

In terminating this notice it may be as well to remark that the question whether Galileo was or was not fraudulently convicted and condemned remains still undecided. The Roman authorities have not as yet taken the one step which offers some chance of settling, and could hardly fail essentially to narrow, the issue. This consists in allowing free access to, and facsimile reproduction from, all and every portion of the Vatican MS., instead of restricting, as appears hitherto to have been done, this privilege to members of the Roman Church supported by ambassadorial or episcopal recommendations.[1]

SEDLEY TAYLOR

THE MANUFACTURE OF SULPHURIC ACID AND ALKALI

A Theoretical and Practical Treatise on the Manufacture of Sulphuric Acid and Alkali with the Collateral Branch. By George Lunge, Ph.D., F.C.S., Professor of Technical Chemistry at the Federal Polytechnic School, Zurich (formerly Manager of the Tyne Alkali Works, South Shields). Vol. i. (John van Voorst, 1879.)

WE heartily welcome Prof. Lunge's volume on the manufacture of sulphuric acid. It is the result of a rare combination of thorough knowledge of scientific theory with that intimate experience of the practical manufacture which can only be gained by those who come into daily contact with the problems presenting themselves in dealing with chemical operations on a large scale.

In his preface our author distinctly states the object he has in view, and very modestly but clearly indicates the claims upon which he founds his right to speak: "The present treatise," he says, "is intended to supply various wants, and accordingly appeals to various classes of readers. In the first place, it gives a scientific description of all the substances occurring in the manufacture of sulphuric acid, alkali, and bleaching powder, either as raw materials or finished products, according to the most recent statements. Secondly, it is intended as an aid in the study of technical chemistry by giving a complete description, both technical and theoretical, of all the processes occurring in this series of manufactures. Its third and principal object is to give to practical manufacturers both complete and reliable information upon all the apparatus and processes which have come under the author's notice. . . . Much space is taken up by the discussion of the innumerable publications in English, German, and French, referring to this industry, but even more space was required for the faithful rendering of the author's personal observations and experiences. His own practice of eleven years in the north of England has been

[1] Wolynski. Nuovi documenti inediti del Processo di Galileo Galilei Firenze, 1878, p. 13.

supplemented by numerous visits to other alkali-manufacturing districts of Britain and the Continent. The author's present position as professor at a technical high school enables him to state frankly what he knows and what he has seen, since he can expect no benefit from keeping anything back."

Every one who reads the volume before us will feel that Prof. Lunge has admirably succeeded in the serious task which he has set himself to accomplish, and there is no doubt that he has thus not only filled up an important lacuna in our chemical literature—for in no sense can any other existing work on the subject be said to be satisfactory—but he has given us a work which must become a standard one.

The importance and magnitude of the British sulphuric acid trade will best be understood when we remember that cheap glass and cheap soap—or light and cleanliness—depend upon the cheap production of oil of vitriol; and when we learn that Great Britain manufactures about five-eighths of the production of the world, and that the annual amount made in this kingdom now reaches the enormous figure of 832,000 tons.

Nor is it in quantity alone—although that is, after all, the true measure of a successful trade—that the English manufacturers stand pre-eminent. In all the great improvements which have taken place, England has fully held her own with her perhaps more highly-educated Continental rivals. Thus, although the introduction of pyrites in place of brimstone is often accorded to Messrs. Perret of Chessy, in 1835, there is no doubt that Mr. Hill of Deptford patented the process in 1818, whilst the first to employ pyrites on a large scale was Thomas Farmer of London. Passing again to the mechanical devices for burning pyrites, we find that Dr. Lunge gives an unfavourable opinion as to the construction and mode of working of the Continental burners, and acknowledges that the English form is that which yields the best results, and is now being largely introduced in both France and Germany.

Then, again, as regards the construction of the now all-important leaden chamber, we find that an Englishman, Dr. Roebuck of Birmingham, was the first to erect such a chamber in 1746. And if it is to the genius of Gay-Lussac in 1827 that we owe the idea of the recovery of the excess of escaping nitrous fumes, by passing the exit gases through a shower of strong sulphuric acid, we must remember that this part of the manufacture was not perfect until Mr. Glover proposed the addition of his denitrating tower. All these, and many other inventions and appliances made by intelligent English manufacturers, are clearly stated by Dr. Lunge, who appears to be perfectly free from bias, and discusses the whole subject with a thoroughly scientific spirit. Our English system of Government inspection of sulphuric acid works also comes in for a proper share of notice and commendation, although we do not find mention made of the labours of the recent Noxious Vapours Commission, founded upon whose report the Government have brought forward a new Noxious Vapours Act, which is to include a large number of works, especially vitriol works, which as yet are not placed under inspection. Several of the various proposals which have been made by the chief inspector, Dr. Angus Smith, and his staff, are dwelt upon. Especially we would notice Fletcher's valuable anemometer for the measurement of the draught in flues and chimneys, upon the results of which the escapes of acid are ascertained.

Dr. Lunge has lived so long amongst us that he not only fully appreciates highly our manufacturing skill, but he is able to express his appreciation in terse and luminous English. The illustrations, too, with which the volume teems are of the highest excellence, drawn, as they all appear to be, to scale, and engraved with the care and precision which is characteristic of the great publishing house of Vieweg and Sons of Brunswick. From whatever point of view we consider his labours, there is no doubt that they will be highly valued both by students and manufacturers, and we can confidently recommend this first volume of Dr. Lunge's work to all those who, from the scientific or from the practical side, are interested in this most important chemical manufacture.

H. E. ROSCOE

OUR BOOK SHELF

On the Origin of the Laws of Nature. By Sir Edmund Beckett, Bart. (London: Society for Promoting Christian Knowledge, 1879.)

THIS is a very clever little book, and deserves to be widely read. Its subject, however, is scarcely one for our columns. For it is essentially "apologetic," and its strong point is not so much accurate science as keen and searching logic. It dissects with merciless rigour some of the more sweeping assertions of the modern materialistic schools, reducing them (when that is possible) to plain English so as to make patent their shallow assumptions. When, from the inherent vagueness of a statement, the author finds himself unable to present it in intelligible and simple language, he gives by apt analogy a clear view of its absurdity. He follows out in fact, in his own way, the hint given by a great mathematician (Kirkman) who made the following exquisite translation of a well-known definition:—

"Evolution is a change from an indefinite, incoherent, homogeneity to a definite, coherent, heterogeneity, through continuous differentiations and integrations."

[*Translation into plain English.*] "Evolution is a change from a nohowish, untalkaboutable, all-alikeness, to a somehowish and in-general-talkaboutable not-all-alikeness, by continuous somethingelsifications and sticktogetherations."

The following quotations, taken almost at random, give a fair idea of the style of the book:—

"You may say perhaps that this is just Hume's famous argument against miracles, viz. that all experience is against them, while lying is not at all contrary to experience. But that again is a mere paradox, or a verbal trick which either begs the question or is absurd. For if by 'all experience' he meant literally all experience, that simply begs the question; and if he meant only general experience, it sinks into the platitude that miracles are uncommon. Again, if the prevalence of lying were a sufficient reason for disbelieving any extraordinary story, then we must not believe that any extraordinary event ever happened: which is absurd."

"In that respect there is no difference between a single atom and that congeries of atoms which for the time makes up a man: at any rate atheistical philosophers admit none: according to them it is matter (*i.e.* the atoms of it) 'that has the promise and potency of life,' and man is only a machine resulting from their spontaneous action under laws and forces which always existed without any cause. But if the most determined man in

the world resolves ever so firmly to walk to a place a mile off, that initial resolution will never get him there unless he further resolves at every moment of his walk to take the next step, and takes it."

" . . . . Atheistic philosophers are always insisting on the fact that whatever powers have made the world, have made it and kept it going and improving by means of invariable laws or modes of action. Then if uniformity of action *of the proper kind* can do the business so well, why should it be varied? This argument against a creative will in other words asserts that there can be no such will because the plan and rules by which it uniformly acts are so good that they have never to be varied in order to repair a single defect or produce a single improvement; *i.e.* 'there is no creator and maintainer of the world because the design was so perfect. If we had seen the universal machine working by fits and starts we should certainly have admitted that every one of them involved a fresh application of power; but we deny any because it works so smoothly that it seems to go of itself, though it is always turning out products of infinite variety, and in some respects continually improving.' Such an argument as that only needs stating nakedly to answer itself. . . . . A machine that will go on for ever producing ever-varying and ever-improving results is manifestly and infinitely superior to one that needs continual interference, and implies infinitely greater wisdom in the maker of it."

" . . . . the leaders of the materialistic school give us such dogmatic statements as that 'materialism is the best working hypothesis,' and that 'it is a fundamental law of psychology that all beliefs as to the past and the present must rest on experience.' But they neither pretend to prove that 'fundamental law,' nor to tell us who made it, except themselves, nor why a hypothesis is the best working one which explains nothing, but merely asserts, when turned into plain English, that things are because they are; and that mind is only the result of certain motions of matter, without professing to explain how a single particle of matter came to be able to move itself . . . . all this language of the materialists or atheists, or sceptics, or whatever else they call themselves, is not demonstration but mere assertion, which could just as well be made the other way."

When the purposely vague statements of the materialists and agnostics are thus stripped of the tinsel of high-flown and unintelligible language, the eyes of the thoughtless who have accepted them on authority (!) are at last opened, and they are ready to exclaim with Titania

Methinks "I was enamour'd of an ass."

As the touch of Ithuriel's spear at once happily revealed the Deceiver, these frank and clear exposures of the pretensions of pseudo-science cannot fail of producing great ultimate good. P. G. TAIT

The Home of the Eddas. By Charles G. Warnford Lock. With a Chapter on the Sprengisandr by Dr. C. Le Neve Foster. (London: Sampson Low, Marston, and Co., 1879.)

ANOTHER volume of Icelandic travel has been added to the lengthy series which already loads the book-shelves of those who are interested in that wonderful country of frost, and flood, and fire. More than fifty such works have been published during this century; some discussing the geology, others the natural history of the country; others the characteristics of the people, and of their literature; many are simply records of travel, some are mere clumsily-constructed diaries. We fear we must class the volume before us among the latter. It is a mere diary, and in good sooth the most intolerably dull diary we ever read. We have searched in vain for any new facts, any new views concerning old facts, any local and individual colouring. The author has travelled over old ground, by the old methods, permeated by the ideas of his predecessors. Let us, however, give him his due. He is a brave man, and a contented man. Never were dangers more pluckily faced; never did a man grumble less under the most trying circumstances. Many men with less perseverance, less hardihood, less indomitable spirit, have made considerable discoveries, achieved great results. He travels twelve or twenty hours at a stretch in mid-winter; he fords foaming torrents; traverses treacherous bogs; crawls all-fours over ice-slopes; puts up with the most miserable accommodation and food, and yet is always cheerful, and always makes the best of things. Often he gets soaked to the skin in a glacier river, and has to sleep in his wet clothes in a pestilential baðstofa. Often after a weary day's march he has to go supperless to bed. That all his labour should have resulted in so little—we fear we must say, in no—gain to art, literature, or science, is quite deplorable. But the fact is, records of Icelandic travel are worn threadbare. More than fifty years ago the works of Mackenzie and Henderson appeared; less than four years ago the two-volumed "Ultima Thule" of Capt. Burton gave us the most recent experiences of an accomplished traveller. For a general description of the country we still prefer Henderson; Baring-Gould's "Scenes and Sagas" furnishes a pleasant, chatty volume of travel, full of north-world lore; while Prof. Bryce's "Impressions of Iceland," in the *Cornhill Magazine* for May, 1874, is the very type of a well-written general article on the subject; full of condensed observation, wide in limit, admirable in style, masterly in treatment. One thing could have partially redeemed "The Home of the Eddas" from its dull monotony: had it been well illustrated with views not commonly met with in Icelandic works of travel, it would have been a redeeming point. But, alas, there is not a single illustration.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Swift's Comet

THE following position of the comet was obtained from three comparisons with the star *Dm* + 84°, No. 60. From a single comparison of the star with *Carrington* 447, the declination of the *Dm* appears to require the correction − 8″, but I have not applied it to the comet's place. The declination of the ephemeris of the comet, in NATURE, vol. xx. p. 248, requires a correction of only + 0′·6.

1879.	G.M.T. h. m. s.	App. R.A. h. m. s.	App. decl. ° ′ ″
July 10 ...	11 14 12 ...	2 57 37 ...	+84 54 0

1, Vanbrugh Park, Blackheath, S.E. G. L. TUPMAN

Hissarlik

I SEE in NATURE, vol. xx. p. 255, a statement, which has also appeared in the *Times*, that Prof. Virchow has written to my friend, Dr. Schliemann, stating that there is a concurrence of geological opinion in Berlin that all the building stones, fragments of which the professor brought home from Hissarlik, are of fresh-water formation. This conclusion it is said is thought to be decisive against those who affirm the impossibility of identifying Hissarlik with the Homeric Troy on the ground that at the time of the great epic, the site must have been covered by the sea. I am, however, unaware that it has ever been argued that the actual site of Hissarlik was covered by the sea, but only that Hissarlik was probably on the sea-shore, a position which would be quite inconsistent with the statements of Homer. I have never committed myself to this opinion, but I

may be allowed to point out that the fact mentioned by Prof. Virchow favours rather than disproves this view. If the plain between Hissarlik and the sea has been gradually formed by the detritus brought down by Scamander the materials would be of fresh-water origin. The observations made by Dr. Virchow appear therefore to me by no means to bear out the conclusions which it is said have been drawn from them.

15, Lombard Street, E.C., July 12 JOHN LUBBOCK

On the Origin of Certain Granitoid Rocks

DR. HICKS has very properly called attention to his prior discovery of the transitional nature of some hälleflintas, and I regret that I overlooked this point in his valuable papers on the Pembrokeshire rocks. I may, however, be permitted to point out that my observations in Shropshire go further than those of Dr. Hicks, since the hälleflinta observed in the Wrekin range passes not merely into "incipient gneiss, the metamorphic action being incomplete, a kind of semi-metamorphism and softening having taken place, etc."; but into a true gneiss, distinctly foliated in bands of quartz, felspar, mica, and sometimes hornblende, and into granitoidite and granite. In the Wrekin we see the completion of the change of which Dr. Hicks recorded the earlier stages. C. CALLAWAY

Wellington, Salop, July 12

The Telephone

EXPERIMENTS that I have recently made with a "Bell" telephone have convinced me that the sounds produced are the result of molecular change in the iron disk, and are the same in kind as those heard in the telephone of Reiss.

My experiments were made with a carbon transmitter and Bell receiver, using a small battery to generate the current. First I removed the bar magnet from the receiver, in accordance with a suggestion made by a writer in NATURE some months ago. The effect without the magnet was the same as with it. It then occurred to me that the intensity of the sound might be increased by using two disks instead of one. Accordingly I cut two circles out of a piece of sheet iron, leaving a narrow strip of the metal to connect them, of sufficient length to enable the disks to lie on either side of the reel, so as to form, in fact, an armature to the electro-magnet. On experimenting with this my anticipations were fully realised, the sound produced being more than double that from a single disk.

Now, while trying these experiments I held the disks loosely in my hand, without their being in any way fastened to the wood holding the reel, the effect being the same as if firmly secured. In fact, a common dinner knife or a rough piece of iron would emit sound if brought near enough to the core of the electro-magnet.

I have since constructed a very efficient telephone receiver out of a block of wood two inches square and three-quarters of an inch thick. I then drilled a hole sufficiently large to receive the reel, and covered the block with thin sheet iron. It needs no ear-piece, and forms the most effective telephone receiver that I have seen. But, still further to prove that the sounds produced are due to the magnetisation of the iron of the disk, and not to mechanical vibrations resulting from the electro-magnet, I made an iron reel, the flanges of which were two inches in diameter. Now, on covering this reel and placing it in circuit, the flanges of the reel gave out sound as clearly as in the Bell telephone. In my judgment this experiment renders it conclusive that the sounds proceed from the magnetisation and demagnetisation of the iron, and are therefore precisely the same in character as those formed by a Reiss receiver.

PERCIVAL JENNS

St. John's Rectory, British Columbia

Inherited Memory in Birds

SOME interesting communications have lately appeared in NATURE on this subject, accounting for the wonderful knowledge of routes and localities displayed by birds in their migrations, by the theory that the impressions made on the brains of the parents are transmitted to their offspring, and that which we call vaguely instinct is often inherited memory.

The following circumstance is hard to explain on any other theory:—

About twelve years ago I was residing on the coast of Co. Antrim, at the time the telegraph wires were set up along that charming road which skirts the sea for twenty-five miles between Larne and Cushendall. During the winter months large flocks of starlings always migrated over from Scotland, arriving in the early morning. The first winter after the wires were stretched along the coast I frequently found numbers of starlings lying dead or wounded on the roadside, they having evidently in their flight in the dusky morn struck against the telegraph wires, not blown against them, as these accidents often occurred when there was but little wind. I found that the peasantry had come to the conclusion that these unusual deaths were due to the flash of the telegraph messages, killing any starlings that happened to be perched on the wires when working.

Strange to say, that throughout the following and succeeding winters hardly a death occurred among the starlings on their arrival. It would thus appear that the birds were deeply impressed and understood the cause of the fatal accidents among their fellow-travellers that previous year, and hence carefully avoided the telegraph wires; not only so, but the young birds must also have acquired this knowledge and perpetuated it, a knowledge which they could not have acquired by experience or even instinct, unless the instinct was really inherited memory derived from the parents whose brains were first impressed by it.

Sudbury, Suffolk J. SINCLAIR HOLDEN

Butterfly Swarms

SOME, at least, of the swarms of *V. cardui* originate in Africa, one of which I witnessed a day's march west of Sowakin, in Nubia, in March, 1869. Our caravan had started for the coast, leaving the mountains shrouded in heavy clouds, soon after daybreak. At the foot of the high country is a stretch of wiry grass, beyond which lies the rainless desert as far as the sea. From my camel I noticed that the whole mass of the grass seemed violently agitated, although there was no wind. On dismounting I found that the motion was caused by the contortions of pupæ of *V. cardui*, which were so numerous that almost every blade of grass seemed to bear one. The effect of these wrigglings was most peculiar, as if each grass stem was shaken separately—as indeed was the case—instead of bending regularly before a breeze. I called the attention of the late J. K. Lord to the phenomenon, and we awaited the result. Presently the pupæ began to burst, and the red fluid that escaped sprinkled the ground like a rain of blood. Myriads of butterflies limp and helpless crawled about. Presently the sun shone forth, and the insects began to dry their wings; and about half-an-hour after the birth of the first, the whole swarm rose as a dense cloud and flew away eastwards towards the sea. I do not know how long the swarm was, but it was certainly more than a mile, and its breadth exceeded a quarter of a mile.

SYDNEY B. J. SKERTCHLY

Distribution of the Black Rat

FROM Prof. Giglioli's letter in NATURE, vol. xx. p. 242, it appears that the black rat is more abundant and widely distributed in Italy than in England. I know of some half-dozen specimens having been caught from time to time in the city of London, and in November, 1876, a male about six weeks old was caught, which lived in confinement for two years and three months. It was mated with a tame white one, and they had two litters of young which were black, save the feet, tip of tail, and a small brush of pure white upon the chest.

CHAS. COPPOCK

Grosvenor Road, Highbury New Park, July 11

Pine Pollen and Sulphur

BY a coincidence which depends upon the season of pollen-discharge occurring at the same period in Scotland as in England, I am enabled to send you an extract from the *Haddingtonshire Courier* of June 27, which may serve to dissipate the "sulphureous theories" of Mr. Carpenter's opponents.

"The rustics in this district [Gifford] have been of late much interested in a peculiar shower which had fallen in the early morning of Monday last. All the pools on the roads were covered and fringed with a powdery substance strongly resembling the flowers of sulphur. A calculating Good Templar found that the fiery powder had been drifted more about the houses of those who loved the flowing bowl than those who loved the

contents of the flowing river. One old woman, however, dispelled the Templar's idea by stating that she had felt the smell of 'brumstane' near her dwelling, and on searching the premises it was found the water-barrel had got a saffron cap on, and was otherwise dusted with the subtle powder. As this mystery, if it is not explained, may prove serious to the nervous, superstitious, or credulous part of the community we may as well add that at this season districts in the neighbourhood of fir plantations run the risk of a thorough dusting of this powder if there is the slightest breeze, as the cones of the young Scots fir are thickly coated with yellow powder or pollen, which will give out a blinding saffron cloud on the slightest irritation."

The laudable desire of our newspaper correspondent to relieve the anxieties of his neighbours at a time when the Presbyterian world is much exercised over the question of eternal and sulphureous punishment, can be fully appreciated only by natives. But in my opinion, the correspondent, in his clear knowledge of the nature of the "brimstone" deposit, exhibits a most praiseworthy tendency to explain the natural in terms of the natural; whilst the incident tends to show at the same time that there are not a few persons in this world to whom a course of elementary studies in natural history would serve as a means of culture, not to say of common protection against ludicrous mistakes such as those against which Mr. Carpenter inveighs. ANDREW WILSON

Edinburgh Medical School

Plague of Rats

I SEE by NATURE, vol. xx. p. 65, that Mr. Orville A. Derby contributes some very interesting information relating to a plague of rats in Brazil, and adding that the plague "is said to occur at intervals of about thirty years, and to be simultaneous with the drying of the *Taquara*, or bamboo, which everywhere abounds in the Brazilian forests." It may be interesting to know that a similar plague of rats visited the higher coffee districts of Ceylon during the year 1875, doing great damage to young and old plantations alike.

It is remarkable that the invasion of rats was simultaneous with the flowering and death of the *Nilloo* (*Strobilanthes*), which forms the greater part of the underwood of Ceylon forests, and is said to flower and die once every seven years. The most remarkable part of the plague was that the rats did not seem to devour any part of the branches they cut off, but to nip off and leave them untouched upon the ground. So serious indeed was the damage done, that on some coffee estates rewards were given to coolies for every rat they caught, and it was not an uncommon thing to hear of three or four hundred rats being destroyed, on *one* estate only, per week.

Between the years 1840 and 1850 there was a similar plague in the Kalebokka coffee district, where the damage done was immense, but I am not aware if it was so general as in the rat plague of 1875. It is to be hoped that we may not again be invaded in 1882, when the *Nilloo* is next expected to die.

Ballangoda, Ceylon, June 16 FREDERICK LEWIS

Glow-worms

SHELLEY sings of a "glow-worm golden in a dell of dew," but last night, at 10 o'clock, while travelling on a bridle path among the bleak lonely mountains of Tynron, Dumfriesshire, bearing up against a high wind with cold rain, I espied three glow-worms shining among the grass and ferns. I had seen them in the same locality before, but scarcely expected to have noticed them in such ungenial weather when summer has with us scarcely yet begun. J. S.

July 8

Headless Butterfly laying Eggs

ABOUT three o'clock on the 11th inst. I picked up a butterfly, probably belonging to the genus *Vanessa*. It was a female, the head of which had recently been plucked off by a bird, and was lying near the body. Thinking it was dead, I carried it home to examine the wing scales. On clipping off a bit of wing about four hours afterwards, the legs moved, and in a short time an egg was laid. In about two minutes another egg was laid. Others followed, till five-and-twenty had been expelled. Tremors of the legs and wings accompanied each deposit. The laying ceased, and the headless mother seemed dead. Next morning, on touching her, the motions of the legs and wings were repeated, and in a short time the laying was resumed. On close examination a heaving of the wings and rings of the abdomen could be observed, with about the frequency of human breathing. At the end of twenty-nine and a half hours from the time of finding, the laying ceased; seventy-eight eggs were laid by the butterfly with her head off. A. STEPHEN WILSON

North Kinmundy, Aberdeen, July 14

THE COMPARATIVE ANATOMY OF MAN[1]

III.

The Mongoloid People of Asia

TO the north and east of the line already spoken of, running northwards from the head of the Bay of Bengal to the north of the Caspian Sea, the bulk of the people of the Continent of Asia belong to the Mongolian, or better, Mongoloid type.

The physical characters of these people, best seen in the so-called Tartars who inhabit the country to the north of the great wall of China, are as follows: the complexion is pale brown, usually with a yellowish tinge; hence they are spoken of as the "yellow races," in contradistinction to the (so-called) white and black races. Their hair is black, perfectly straight, and coarse. In microscopic section it is seen to be of large size, and more inclining to cylindrical than in other races, but it varies much. Except on the scalp, where the hair is often long, the capillary development is very scanty. On the face it is often limited to two slender pencils on the upper lip; and the beard, when developed, is acquired comparatively late in life. The face is broad and flat; the space between the eyes is wide; the nose small, straight, and compressed; the eyes dark and small; the aperture between the lids narrow and somewhat oblique, being raised at the outer corner; the upper lid drooping, the inner corner partly covered by a vertical crescentic fold of skin; the cheeks very prominent; the mouth and lips of moderate size, the lower lip often hanging; the chin small and sharp.

The osteological characters of the typical Mongolian are more marked in the face than in the cranium, for the latter may vary between the extremes of brachycephaly and dolichocephaly, though the former prevails. The face is large, being both high and broad; the forehead flat, the glabella and superorbital ridges slightly developed; the orbits round, with thin sharp margins, the sub-glabellar nasal depression very slight; the nasal bones narrow and flat; the whole framework of the nose inclining to the leptorhine form; the jaws of medium prominence; the arch of the mouth broad and round; the malar bones both broad and deep. Perhaps the most distinctive feature of the Mongoloid face, which gives it the characteristic appearance, is the forward position of the outer margin of the orbit, as compared with the median line of the face. In order to estimate this character with exactness, Prof. Flower measures the angle formed between two horizontal lines meeting at the most depressed point of the nasal bones in the middle line (the apex of the angle) and resting on the middle of the outer margins of the orbit. This *nasi-malar* angle gives valuable average results. For instance, the average of 130 European skulls is 131 deg., of the twenty Maravars mentioned in the last abstract, exactly the same; of 20 African negroes 134 deg., and of 20 Australians 135 deg. In all of the true Mongolian races, the average exceeds 140 deg. Thus, in 4 Samoyedes it is 144 deg.; in 16 Chinese, 142 deg.; in 7 Japanese, 141 deg.; in 4 Burmese, 144 deg.; in 26 Eskimo, 144 deg.

The Mongoloid races of Asia are conveniently divided into two groups, the northern and the southern. The former, called Mongolo-Altaic races, are united by languages having considerable affinities. They nearly all lead a nomadic life, depending for their living on hunting, fish-

[1] Abstract of Prof. Flower's Hunterian Lectures, delivered at the Royal College of Surgeons, commencing on Wednesday, March 5. Continued from p. 246.

ing, and cattle-breeding. Occasionally, when united under the leadership of some military chieftains of extraordinary capacity, as Attila, Tchinghis Khan, and Timur, they have overrun nearly the whole of the continents of Asia and Europe; now, however, they are everywhere either the actual subjects, or live by sufferance, of the people over whom they formerly terrorised—the Russians, Chinese, &c.

The anatomy of these races is only represented in the museum by a complete skeleton and several skulls of Samoyedes, a people now inhabiting the most inclement parts of North-western Siberia. They were conquered by the Russians in 1499. They are dwellers in tents made of pieces of bark covered with reindeer skins, and live chiefly by fishing and the chase, and by the produce of the herds of reindeer which they keep. Their external physical characters are always described as being typically Mongolian. Their skulls are very broad and low, the average latitudinal index of four being 847, and the average altitudinal index 719. They are, therefore, decidedly brachycephalic. The orbits are round (megaseme), the average index being 938; the nasal index is 431, so that they are truly leptorhine; the alveolar index of 102 shows them to be mesognathous, with a strong inclination to prognathism. The skeleton, that of an old male, is slightly below five feet in height. The pelvic index is only 78, but both bones of the upper extremity are disproportionately long compared with those of the lower limb, and the radius and the tibia are relatively longer compared with the proximal segments of the limbs than in Europeans.

The Turks, the Magyars, the Finns, and other representatives of the Mongolian type, have for so many generations intermingled with the people through whom they have passed in their migrations, that their original physical characters have been completely modified. Even the Lapps, a diminutive race of nomads, inhabiting the most northern parts of Europe, supposed to be of Mongolian descent, show so little of the special attributes of that race, that it is difficult to assign them a place in a classification based on physical characters. Their crania are remarkably capacious, one in the collection being as large as 1,800 c.c., and another 1,600. They are brachycephalic, have a latitudinal index (average of seven) of 812. The orbital index of the same number is 984. The nasi-malar index, though lower than in the true Mongolian, being about 136°, is higher than in the other Europeans.

Races of Eastern Asia

Many races of Asia, of similar physical type to the Mongolian, are divided from the Altaic group by language and by mode of life. One large group is formed by the people of Thibet and Burmah, with various tribes dwelling within the north-eastern frontiers of India. The four Burmese crania in the museum are all short, high, round, or rather square skulls; the average latitudinal index is 82, and the altitudinal index nearly as high. The orbital, nasal, and alveolar indices are all moderate. The nasi-malar angle of 144° is thoroughly Mongoloid. From the Burmese, the transition (physically) to the Malays is very easy; and through the Malays, the purer races of the Polynesians are connected with the inhabitants of Central Asia.

The various races constituting the population of the vast empire of China all belong to the Mongolian type, and have gradually moved southwards to their present dwelling-places. The existing reigning dynasty is Mandschurian, belonging to the Tungus branch of the Altaics. The Chinese proper formed their earliest settlements in the north-western provinces of what is now called China about 2000 B.C. The aboriginal tribes they found there still exist, as the Miaw or Miautze, &c.

The following cranial characters of the Chinese are deduced from sixteen specimens of the male sex:—The average capacity is 1,424. The index of breadth is 782, so they fall under the mesocephalic category, inclining to brachycephaly. All the other Mongolian races hitherto treated of have been decidedly brachycephalic. The height-index is lower, viz., 753. The general form of the face is Mongolian, the forehead smooth, with little development of the glabella, the space between the orbits wide, the malar bones large and prominent, the anterior root of the jugal arch stands out laterally from the face, then turns sharply backwards beyond the maxillo-jugal suture, instead of gradually sloping backwards from that point, as in the English skull. The nasi-malar angle is 142 deg. The orbital, nasal, and alveolar indices are all medium, being respectively 869, 504, and 993.

The Japanese differ entirely from the Chinese, and resemble the Altaic races in the polysyllabic character of their language. They appear to have migrated from the Asiatic continent to the islands they now inhabit in the seventh century B.C., first taking possession of the southernmost island, Kiu-siu, and soon afterwards passing on to Niphon, gradually driving out the original population, the Ainos. It is, however, probable, that some portion of the latter became absorbed into the conquering race, which circumstance may account for part of the diversity of features and type seen among them. In the main the physical characters of the Japanese are Mongolian. At present we have really very little information about their anatomy. There are but six male skulls in the College Museum, which give the following averages:—Capacity, 1,486; latitudinal index, 771; altitudinal index, 753; orbital index, 910; nasal, 472; alveolar, 971; nasi-malar angle, 141 deg.

The people who inhabited Japan before the Japanese are called the Ainos. They have lately attracted much attention from ethnologists, owing to the fact that in their physical characters, manners, and customs, they entirely differ from all the other races of the part of the world in in which they dwell. They formerly inhabited the whole of the Japanese islands, Saghalien, and the Kuriles. They are mentioned in Chinese books before the time of Confucius, under the significant title of the villous or hairy men, and are called by the Japanese, "Mo-sins," a word having the same signification. "Aino," in their own language, means "the men," or "the people." Their numbers are now extremely reduced, and the territory they occupy limited by the encroachments of the Japanese from the south, who have driven them up to the most northern part of the island of Jesso, while the Mandschu Tartars have taken from them more than two-thirds of the Island of Saghalien. Though their language has received a considerable infusion of Japanese and Mandschu words, it appears to be of fundamentally different origin. They have no agriculture, and live principally by fishing and hunting, shooting deer and bears with the bow and arrow. They appear to be good-natured, honest, and of a mild, contented disposition.

In stature they are short (the men about 5 feet 2 inches in height), but stouter made, and more hardy and muscular, than the Japanese. Their head is large, their colour rather dark; their forehead low, the superciliary ridges prominent, the nose straight, short, and thick, and rounded at the end. The eyes are open, and not oblique like those of the Mongols, and bright, sparkling, and intensely black. What distinguishes them most in external appearance from all the surrounding races is the abundant development of their hair and beard, but this has been much exaggerated; it is black, coarse, straight, and shaggy; that on the head is worn long over the shoulders, and mingles with the beard. The few skulls known are heavy, and have the muscular impressions strongly marked. The average altitudinal index of four in Dr. Barnard Davis's collection is 78; of three measured by Prof. Flower, 74·3. These present none of the

features characteristic of Mongolian skulls, the facial bones being more European in type, and the nasi-malar angle only 129 deg. The affinities of the Ainos are at present a matter for speculation.

The Eskimo

The original inhabitants of the whole of the New World are light brown, or copper-coloured, have straight black hair, and show, amid considerable diversity in detail in particular regions, a far greater resemblance than can be found in any other portion of the world's surface of equal extent. The Eskimo, inhabiting the most northern portion of the continent, stand, in many respects, apart from the others, and are evidently quite as nearly allied to some of the Asiatic races as they are to the Americans. These people call themselves *Innuit*, which signifies nothing more than "the men," or "the people." The word *Esquimaux*, as it is rendered in French, or *Eskimo*, in the Danish method of spelling, now usually adopted in this country, was applied to them by a neighbouring tribe of Indians, and is said to mean "eaters of raw flesh." They dwell in various scattered localities near the northern coast of North America and the great adjacent islands, from Behring's Straits to Greenland, and on the north coast of Labrador. Like the Mongolo-Altaic races of Asia, they lead a nomadic life, modified somewhat by the peculiarities of the surrounding physical conditions, dwelling in tents in summer, and in houses of snow in winter. Agriculture being impossible in such a climate, their only means of subsistence is hunting and fishing. The flesh of seals, cetaceans, and reindeer forms their principal food. In the pursuit of the two former by sea they use boats, which they manage with great dexterity. They train dogs to draw their sledges, but, unlike the Laplanders, do not domesticate the reindeer. They clothe themselves comfortably in dresses of skin, and employ bows, arrows, and harpoons in the chase. In Greenland they have reached a considerable degree of civilisation, but even here, as elsewhere, their numbers seem to be diminishing.

The Eskimo are generally below the middle size; their head is large, their legs short, and their hands and feet small; their complexion is dusky or swarthy. Their hair is black, straight, and coarse, the beard and moustache generally scanty, though sometimes moderately developed. The eyes are small, black, and sparkling; the elevation of the outer end of the aperture and the vertical fold covering the inner canthus, spoken of before as characteristic of the most typical Mongolian races, have often been observed in them. The nose is usually straight and narrow, and more or less sunken between the prominent cheeks. The mouth is large and the lips rather prominent, generally kept somewhat apart. The chin is small and pointed.

The College Museum contains as many as twenty-seven adult skulls of Eskimos, twenty-four of which are in a condition to form reliable measurements. Of these seventeen appear to be those of males and seven of females.

A typical Eskimo skull always presents such marked characters that it can never be mistaken for that of any other of the groups of mankind. It is of very large size, especially in relation to the rather small stature of the people, the average capacity of 17 male crania in the collection being 1,546 c.c. or 94·3 c. inches. This is almost exactly the same as the average English (of the lowest class), but it exceeds that of 74 modern Italian males by 71 c.c., and it is above the average of Australian males by as much as 261 c.c. or 16 c. inches. The large size of the brain of all hyperborean races, Lapps as well as Eskimo, seems not necessarily to be connected with intellectual development, but may have some other explanation not at present quite apparent. The next distinctive character of the Eskimo skull is its great length and narrowness, especially in the upper part. The base is fairly broad, and the mastoid processes are well developed; but, instead of expanding upwards to the parietal region, it narrows, and, towards the median line above, contracts so rapidly that the upper part of the skull has the form of the roof of a house. Measurements of various series of Eskimo skulls give remarkably uniform results as regards the latitudinal index, the average being from 71·2 to 71·4, so that it may be considered as perfectly established, that the Eskimo are among the most dolichocephalic of races. The female skulls are somewhat broader than the male. The index of height is somewhat greater than that of breadth, averaging 73·5. The cranial sutures are very simple; and among the specimens examined there is no case of metopism or persistence of the frontal suture, nor is there any case of the squamosal bone meeting the frontal at the pterion.

The whole face is large, both high and broad; the forehead is flat, the glabella little developed; the orbits are round, and the malar bones of great size and very prominent, giving a nasi-malar angle of 144 deg. The nasal bones are small and narrow, often coming to a point at their upper ends, and the whole aperture is very long and narrow. The Eskimo are, in fact, the most leptorhine of all races; the average nasal index of the 17 male skulls before spoken of, being only 42·2, the average of European crania being about 47, and that of Australians 56. The projection of the jaw is moderate, giving an alveolar index of 100·8, which brings them into the mesognathous category, with an inclination towards prognathism. The arch formed by the series of teeth is remarkably short, broad, and round. The teeth are small, and generally become worn down to stumps as life advances.

Two out of the three Eskimo skeletons in the Museum possess one more than the usual number of vertebræ, the additional one being interposed between the dorsal and lumbar series, and partaking of the character of both. The brim of the pelvis is remarkably wide transversely, and thus, as also in the limbs, they deviate widely from the negro type: for example, the humero-radial index, which in the Andamanese is as high as 82, in Negroes 79, in Australians 77, and in Europeans 74, does not exceed 71·3 in either of the three skeletons, the average being 71·1.

Dr. Barnard Davis has shown that the special peculiarities of the Eskimo skull are most marked in Greenland; there is also good evidence that the Eskimo have migrated from the west towards the east, and did not reach Greenland, at all events in its southern parts, until the fourteenth century. Their affinities, moreover, as shown by physical characters, are more with the inhabitants of North-Eastern Asia than with the American Indians, and it is not at all improbable that they are derived from the same stock as the Japanese. In this case the peculiarities by which the Eskimo are differentiated from the Asiatic Mongolians cannot have been developed by crossing with other nations, on account of their complete isolation, but must be attributed to those gradual modifications, produced by causes at present little understood, by which most of the striking variations we have met with in the human species have been brought about; modifications more strongly expressed the more completely isolated the race has become, and the further removed from its original centre of distribution.

OUR ASTRONOMICAL COLUMN

THE DUNSINK OBSERVATORY, DUBLIN.—The third part of "Astronomical Observations and Researches made at Dunsink, the Observatory of Trinity College, Dublin," has been published by Dr. Ball. It contains four papers, the first by the previous director, Dr. Brunnow, presenting a discussion of observations of the

planetary nebula H. IV. 37, the position of which is in R.A. 17h. 58m. 36s., N.P.D. 23° 21′·8 for 1880. The nebula appears in the South-refractor as a somewhat elliptical disk, whose major axis is about half a minute, and has in the centre a well-defined point resembling a star of the eleventh magnitude. This point was compared in declination with a star to the north of the tenth magnitude, preceding the nebula by 25s., the same method of observing being used that had been adopted in Dr. Brunnow's earlier researches on stellar parallax. The observations extend over thirty-three nights, from 1871, August 13, to 1872, August 6, and their discussion gives for the parallax of the nebula, + 0″·047 ± 0″·030. Prof. Bredichin, in "Annales de l'Observatoire de Moscou," vol. iii., has found a negative parallax (− 0″·064 ± 0″·039), using also the method of differences of declination with the same star of comparison. The results of these investigations may be taken to indicate that the parallax of this planetary nebula if measurable at all must be very small. The second paper contains Dr. Ball's observations of 61 Cygni, and his determination of its parallax therefrom. By what was at first an inadvertence, instead of using the following of the two components as Dr. Brunnow had done, the preceding one was observed, and the mistake not being remarked until the series was considerably advanced, it was resolved to complete it as begun; perhaps the result possesses for this reason additional interest. Dr. Ball finds for the parallax + 0″·4654 ± 0″·0497, which is about a mean of the values obtained by Bessel, Johnson, Peters, Struve, and Auwers, which appear entitled to the greatest weight. The observations extending from 1877, July 3, to 1878, June 1, are given in their original form. The third paper, also by Dr. Ball, relates to "observations in search of stars with a large annual parallax," forty-two stars being examined for this purpose, including several red and variable stars: the results, however, are found to be entirely negative as regards the object in view, no amount of parallax worth following up being suggested. The principle upon which the observations were made is fully described and their details appended to the memoir. The last portion of the Dunsink publication contains Dr. Brunnow's measures of double-stars 1870–73.

THE SOLAR ECLIPSE OF JULY 19.—The Observatory of Paris is situate very close upon the northern line of simple contact in this eclipse, which will add interest to observations that may be made there. The *Connaissance des Temps* employing the lunar tables of Hansen and the solar tables of Leverrier, gives the magnitude of the eclipse only 0·013 (the sun's diameter being taken as unity), commencement at 7h. 46·1m. A.M. mean time at Paris, ending at 8h. 5·4m. At Gibraltar the magnitude of the eclipse will be 0·32 at 7h. 9m. local mean time, and at Malta 0·38 at 8h. 46m. As we have before remarked the only civilised station where a great eclipse is likely to be witnessed is Aden. The eclipse is strictly an annular one, but the moon's augmented semi-diameter is only five seconds less than the sun's semi-diameter, where the greatest phase occurs near apparent noon. At Aden at 0h. 12m. P.M. 97-100ths of the sun's diameter will be covered by the moon; the line of annular eclipse falls upon the opposite African coast.

PERIODICAL COMETS IN 1880.—Two known comets of short period will be observable before the end of the ensuing year, viz., Winnecke's, which may be in perihelion early in December, and Faye's, which, according to Dr. Axel-Möller, again arrives at its least distance from the sun in January, 1881. The perturbations of Winnecke's comet during the actual revolution will not be important, and from Prof. Oppolzer's elements of 1875 it seems likely that difficulty may be experienced in securing observations, the track in the heavens if we assume the time of perihelion passage to be December 1·5 being as follows:—

1880–1.	Right Ascension. ° ′	Declination. ° ′	Dist. from earth.
Oct. 2	196 29	− 0 15	2·223
Nov. 1	224 3	− 11 35	1·944
Dec. 11	276 17	− 23 21	1·753
21	290 43	− 23 40	1·767
31	304 31	− 22 43	1·808
Jan. 10	317 14	− 20 46	1·876
30	338 44	− 15 13	2·072

METEOROLOGICAL NOTES

THE Eleventh Contribution to Meteorology by Prof. Loomis appears in the *American Journal of Science and Arts* for this month. With the view of inquiring whether areas of low atmospheric pressure sometimes result from a circulation of the surface winds not extending to a height of 6,000 feet, Prof. Loomis has examined eighty-nine storms and compared in each case the average direction and force of the surface winds near the base of Mount Washington with the winds at the top of the mountain. In the majority of those cases in which a storm with its area of low barometer passes over the New England States, the usual system of circulating winds which prevails at the surface, does not extend to the height of 6,000 feet. In cases, however, when the depression is unusually great, this system of circulating winds extends to that height. When the system of circulating winds reaches to the top of Mount Washington, the change of wind into the east usually begins near the base eleven hours sooner than on the top of the mountain; and the change subsequently into the west usually begins at the base five hours sooner than on the top.

IN the same paper Prof. Loomis examines eight storms, the average courses of which were approximately from south to north, and six storms which travelled from north to south, with the view of obtaining information from such abnormal storm paths, regarding the causes which determine the movement of storms with their low barometers from place to place. These two groups of storms present characteristics very different from each other. As contrasted with the other group, storms moving to northward show a central pressure, becoming more depressed as they advance; the southerly winds accompanying them are marked by a greater humidity and velocity; and the rainfall is very greatly in excess. If attention be exclusively directed to storms moving to northward the facts seem to favour the idea that in a great storm the condensation of vapour is an efficient cause which controls the movement of the winds. Storms moving to southward, however, show very different results, areas of low pressure being observed to be formed with little rain and sometimes even with none at all. The general conclusion the inquiry seems to point to is that the initial depression of the barometer is the result of a system of circulating winds, the most frequent cause of which is two or more areas of high pressure at considerable distances, often 1,400 miles from each other, differences of temperature and humidity being important agents in producing, but more especially in maintaining, such a system of winds. If this be so, then the points in the inquiry calling for the most serious attention are the causes which conspire in bringing about those wide areas of high pressure round a region of lower though still high pressure and the concentration of moister and warmer air over this region.

THE *Results of the Meteorological and Magnetic Observations for* 1878 made at Stonyhurst College have just appeared. To the routine work of the observatory has been added the preparation of an agricultural report sent weekly to the Meteorological Office; and to the usual observations are added observations of crops, flowers, shrubs, and trees, and a complete and very valuable table

of the directions in which the upper clouds (cirri) were observed to move during the year with the dates, and the direction and force of the surface winds at the same times. The meteorological observations made at Kerguelen Island during the Transit of Venus Expedition have been discussed, together with those made on board the *Challenger* and the *Erebus* and *Terror;* and the three series of results have been handed over to the Meteorological Office for publication. Their appearance will be looked forward to with the greatest interest on account of the well-marked and extraordinary differences between the daily fluctuations at Kerguelen Island and those in similar latitudes of the northern hemisphere. An extremely interesting table is given showing the monthly rainfall for the thirty years ending 1877. The results show a maximum in October and a minimum in April and May, which agree with the same phases of the rainfall over similarly situated places in this part of Great Britain. The curves of amount and frequency of rainfall show an increase during the past twenty years. They show also a minimum about 1855, and, though not a minimum, yet a distinctly marked depression about 1866, the next minimum sun-spot.

FROM the "Results of the Rain Observations made in New South Wales during 1878," just published under the superintendence of Mr. Russell, Government Astronomer, we learn with extreme satisfaction that this important element of climate is now being observed at ninety-six stations, fairly well distributed over the Colony. A large map accompanies the report, showing the positions of the rain-stations by black circles, the size of which are proportional to the amount of the rainfall for the year, the largest being Fort Macquarie, on the coast, representing 62·50 inches, and the smallest Lake Boulka, 5·61 inches. Setting aside a few local deviations, due to physical configuration, and probably in one or two cases to the shortness of the period (one year), the amounts show, as was to have been looked for, a gradual diminution from the coast inland. The manner and amount of this diminution over the different districts the observations of future years will disclose. The results of this system of observation, taken in connection with the systems of Queensland, South Australia, West Australia, and Victoria, will in a few years go far to solve the important practical problem of the distribution of the rainfall over Australia. An interesting table is given of the mean height above summer level of the Murray River at Echuca, thirty miles south of Deniliquin, from 1863 to 1878. The annual amounts show decided minima about 1866 and 1877, separated by a maximum about 1871; and the monthly amounts a great excess from July to December, when the mean height above summer level is 17½ feet, as compared with 5⅓ feet of mean height during the other six months. The annual maximum floods varied from 18⅓ feet in 1855 and 1877 to 38 feet in 1870, and the average date of their occurrence is early in October.

GEOGRAPHICAL NOTES

IN its issue for July the *Financial and Mercantile Gazette* of Lisbon publishes a map of a portion of Africa, for which it is indebted to the courtesy of Major Serpa Pinto, and on which that explorer's course through the Dark Continent is laid down. The map is rendered the more interesting by the fact that it also shows the routes followed by Livingstone, Cameron, and Stanley. Last night, as we intimated last week, Lord Northbrook, as President of the Geographical Society, gave a reception in Major Pinto's honour, at which a large number of eminent geographers and others were present.

THE Tlemcen *Courrier* (Algeria) describes a large subterranean lake recently discovered at the Cascades of Tlemcen. The opening seems to have been brought to light by some workmen who blasted a large rock at the Cascades. Entering in a rude boat the cave thus exposed they sailed for about three kilometres by the aid of torches, which revealed magnificent stalagmitic columns joining the roof and the bed of the lake. The other end of the lake seems to give off a stream at Sebdou supposed to form the source of the Tafna. The account given by the *Courrier* is rather vague. It states the lake abounds with blind fish, many of which were caught.

THE first number has reached us of a new monthly periodical, entitled *L'Afrique explorée et civilisée* (Geneva: Sandoz), to the prospectus of which we referred recently. It does not contain much new information, except, perhaps, as regards the Belgian Congo flotilla, the proceedings of which we shall watch with great interest. With the endless misfortunes of the International Association's land expedition in Eastern Africa before our eyes, we fear that great things must not be expected, unless, indeed, Mr. Stanley be eventually placed in supreme command. The number contains a map of the continent, which has been specially prepared by Lieut.-Col. Adan, the head of the military cartographical establishment at Brussels, and on which are shown the routes of recent explorers of Africa.

THE *Colonies and India* furnishes some interesting information in regard to the geographical aspects of the scheme for constructing a railway across the Sahara from Algeria to Timbuktu. An expedition is to start in September to make a careful survey of the route, and in order that it may be supplied beforehand with the best information procurable, prizes to the value of 200*l*. are offered for the best papers descriptive of the country between Golaeh and Timbuktu. Opinions appear to be conflicting as to the practicability of the scheme. M. Soleillet, whose recent journey in West Africa we have before alluded to, thinks unfavourably of it; but MM. Foureau and Fau, who have lately explored a large part of the country south of Algeria, aver that the so-called desert is hardly a desert at all.

UNDER the title of "Le Laos et les Populations sauvages de l'Indo-Chine," the *Tour du Monde* has just commenced the publication of an account by Dr. Harmand of his travels in the interior of the Indo-Chinese peninsula in 1877. The narrative is illustrated by well-executed and interesting engravings from sketches and other material furnished by the author.

THE leading paper in the June number of the *Bulletin* of the Paris Geographical Society is an Introduction to the Monuments of Geography by the late M. Jomard, edited by M. E. Cortambert; the present instalment is mainly a history of the progress in the art of map construction. M. Opegez describes a journey made by himself and some companions from Buenos Ayres to Jackal at the foot of the Andes, and Prof. Paul Chaix contributes interesting notes on Siam, an Egyptian Calendar, and the First Meridian; he does not see any inconvenience in the present variety of first meridians. We are glad to see that the *Bulletin* is getting more and more prompt in publication.

IN No. 81 of the *Zeitschrift* of the Berlin Geographical Society Herr K. Himly treats at considerable length of two Chinese cartographical works, and Herr Beuster, a German missionary, gives the result of his observations on the Vainenda, an African people settled in the north-east of the Transvaal "Republic," as he still calls this British possession. The *Verhandlungen* of the same Society, No. 6, contains a paper by Dr. Junker on his three years' travels in Central Africa; while Dr. Kiepert briefly describes some recent explorations to the north-east of the Caspian Sea, hitherto but imperfectly known.

PROF. MOEBIUS ON THE EOZÖON QUESTION

THE eminent zoologist, Dr. Karl Moebius, of Kiel, has recently published a treatise, "Der Bau des *Eozöon canadense* nach eigenen Untersuchungen verglichen mit der Bau der Foraminiferen" ("The Structure of *Eozöon canadense*, according to my own Investigations, compared with the Structure of Foraminifera"), which first appeared in the "Palæontographica" (vol. xxv.), and was afterwards republished separately. Prof. Moebius inclines entirely towards the view of King and Rowney

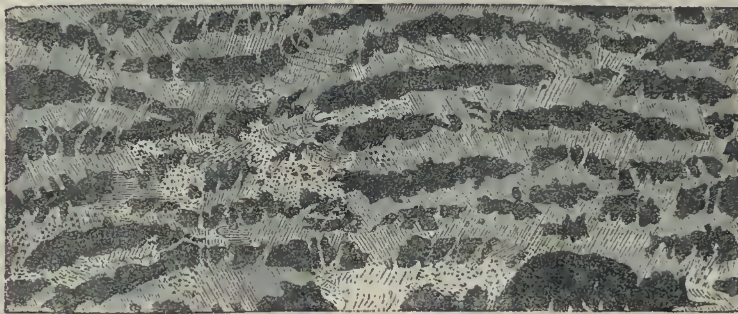


FIG. 1.

(*Proc. Roy. Irish Acad.*, ser. 1, x. and ser. 2, i.) disputing the organic character of Eozöon. The question is one of such great interest, and the paper is so sure to originate controversy, that we have no doubt the following abstract of the chief points in Dr. Moebius's treatise will be welcomed by our readers.

After a concise account of the history of the Eozöon question, since the remarkable discovery by Prof. Dawson and the detailed investigations made by Prof. Carpenter, Dr. Moebius commences the discussion of the subject by stating that he was first led to the study of Eozöon through observation of the structure of a

FIG. 2.

rhizopod, found by him in 1874 on the coral reefs near Mauritius, and to which he had given the name of *Carpenteria rhaphidodendron*. This consists of tree-shaped individuals which often form turf-like growths of several centimetres in length, breadth, and height. Sections of such growths surprised Dr. Moebius by their great likeness to the representations of Eozöon sections accompanying the descriptions published by Dawson, Gümbel, Fritsch, &c. He therefore resolved to make a careful investigation of Eozöon and to compare it with *Carpenteria rhaphidodendron* and other foraminifera, in order to form his own judgment regarding its nature, and to

establish such reasons and facts as might lead to a generally acceptable and final decision of the Eozöon question.

Fig. 3.

With this object in view Dr. Moebius investigated upwards of ninety Eozöon sections, of which many were placed at his disposal through the kindness of Dr. Carpenter, and of which many others originally belonged to Prof. Dawson; there was no doubt, therefore, that the sections possessed those properties which had led the latter to declare the formation to be of animal origin. According to Dr. Moebius *Eozöon canadense* consists principally of alternate layers of yellowish green serpentine and whitish limestone. Fig. 1 is the representation of a good Eozöon section, magnified four times.

The darker parts represent the serpentine, the lighter ones the limestone which in many places completely surrounds little rounded nodules of serpentine. Both the limestone layers, as well as the serpentine layers, have indentures and frequently end in wedge-shaped points. They generally attain a thickness of two or three millimetres. In the limestone, even when magnified only four times, the straight and parallel division lines of the thin layers of which it is composed are easily seen. Besides these division lines groups of little dots or of curved lines are noticed, representing stems and thin plates imbedded in it. These stem- and plate-shaped formations, which are of great importance with regard to the introduction of Eozöon amongst foraminifera, will be better recognised in Fig. 2.

This represents a small part of an Eozöon section, from which the limestone has been dissolved by hydrochloric acid, magnified forty times, under reflected light. The acid has only left the serpentine and the stems and plates, which, like serpentine, consist principally of silica

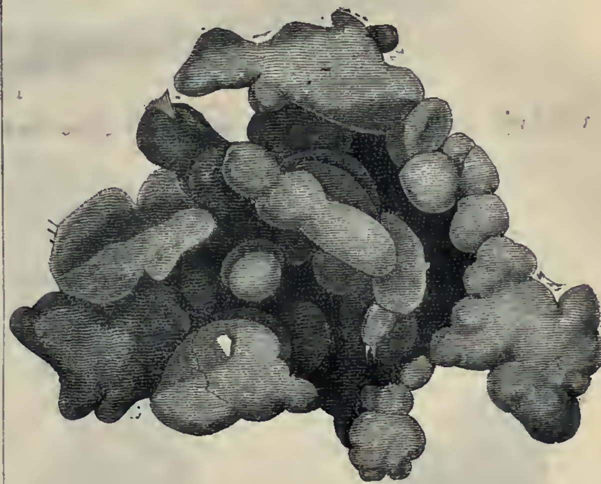


Fig. 4.

and magnesia. Between the indented bands of serpentine (s s) we see cavities which were formerly filled up by carbonate of lime. From the bottom of these cavities, which also consists of serpentine, stems and plates of

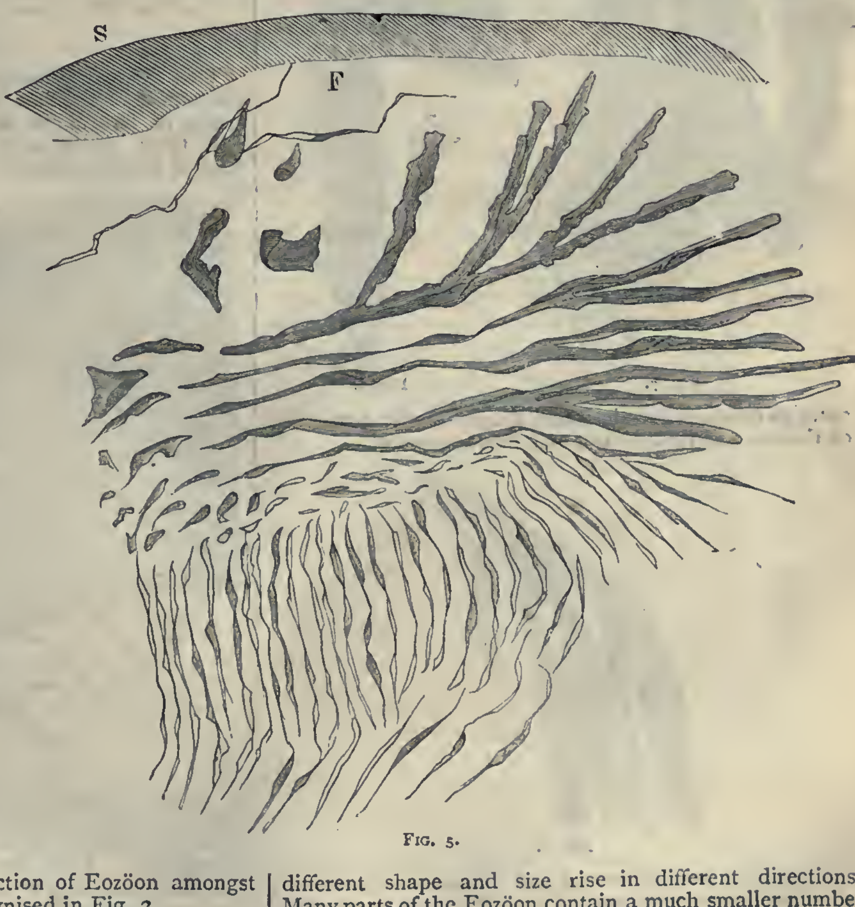


Fig. 5.

different shape and size rise in different directions. Many parts of the Eozöon contain a much smaller number

of stems than are shown in Fig. 2, such as the piece represented in Fig. 3, where the lime is also removed, and which is also magnified forty times. Still poorer in stems is Fig. 4, where only a few nodules of serpentine are pro-

FIG. 6.

vided with stems. Figs. 3 and 4 may at the same time serve to illustrate certain round shapes in the serpentine of Eozöon and their almost spiral arrangement.

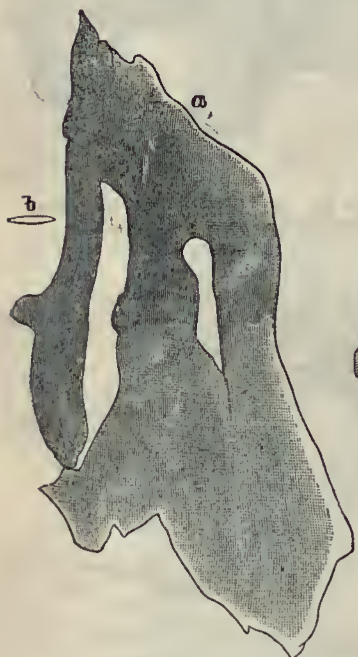


FIG. 7.

FIG. 8.

FIG. 9.

If Eozöon sections are cut and ground to such thinness that they become translucent, then they may be examined by yet more powerful microscopes and under transmitted instead of reflected light. Most of the stems then appear distinctly as simple or ramified, bent plates, giving generally concavo-convex, much less frequently bi-convex or oval cross-sections, as illustrated by Fig. 5.

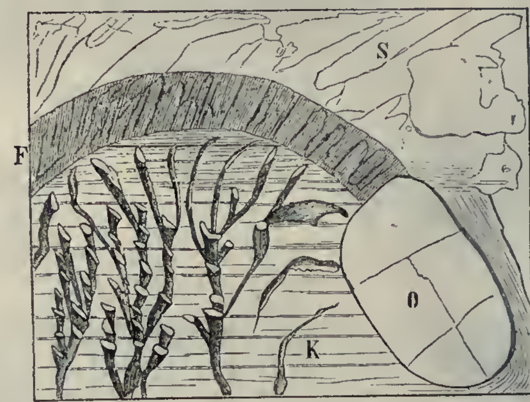


FIG. 10.

This figure represents stems magnified 150 times. A the margin of the lime in which the stems are imbedded bands of fine fibres are seen; we shall refer to these and their significance with regard to the introduction of Eozöon amongst foraminifera. Perfect certainty

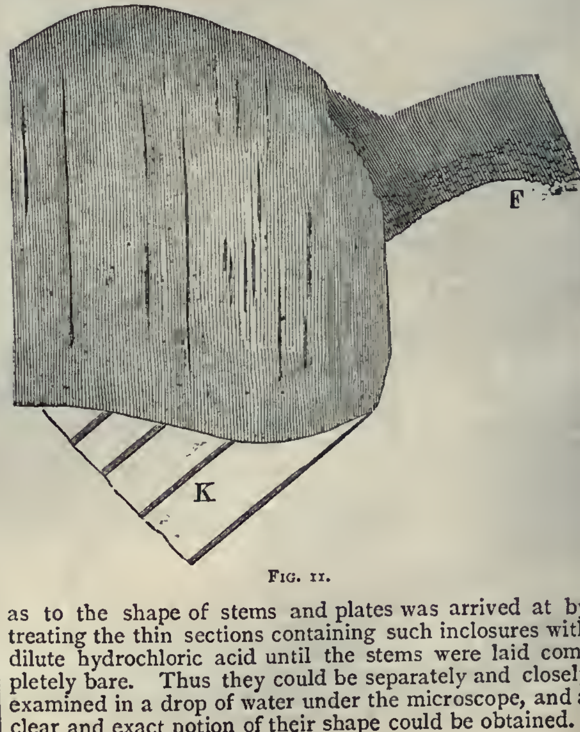


FIG. 11.

as to the shape of stems and plates was arrived at by treating the thin sections containing such inclosures with dilute hydrochloric acid until the stems were laid completely bare. Thus they could be separately and closely examined in a drop of water under the microscope, and a clear and exact notion of their shape could be obtained.

Figs. 6 to 9 represent several stems and plates isolated in the manner described and magnified 350 times.

Fig. 6 shows a bent and half tube-shaped stem; Fig. 7 a plate with two apertures; Fig. 8 a plate with alternate and parallel thicker and thinner parts; Fig. 9 a ramified stem of similar structure. In Fig. 6 the shape of the cross-section is indicated. The alternately thinner and thicker parts in Figs. 8 and 9 correspond to the lamellæ of the lime in which they laid imbedded, and therefore probably have their origin from these.

Now we have only to consider the fibres, which in many parts of the Eozöon, at the borders of the calcareous parts carrying the stems, surround the serpentine-like bands, but which in other parts pass right through the serpentine. In Fig. 5 these fibres are marked F, while the serpentine is designated by S. A very well-defined band of fibres is seen in Fig. 10 (magnified 200 times), between the serpentine S and a piece of lime in which obliquely ascending stems are cut right across at the surface of the section. O is a crystal of olivine in course of decomposition, and therefore no longer possessing sharp edges.

The fibres are imperfectly developed micro-crystals of chrysotile, which like olivine and serpentine consists of silica and magnesia. In many fibre-bands, with the application of strong magnifying powers, it is observed that the fibres are very small four-sided prisms. In Fig. 11, near F, such fibres are shown, magnified 500 times; to the left are long, less distinct, needle-shaped chrysotile crystals, besides lime (K).

(*To be continued.*)

NOTES

We have received from the U.S. Signal Office the monthly *Bulletins* for November and December, 1874, January, 1875, and January, February, and March, 1877. We hope shortly to begin, through the courtesy of General Myer, the regular publication of a map exhibiting the simultaneous monthly means in meteorology of the whole of the Northern Hemisphere. The immense value of such a publication to meteorological science we need not point out, and the enterprise of the U.S. Signal Office in working out and making public these data is beyond praise.

The Astronomical Museum established by Admiral Mouchez in the Paris Observatory may be considered as now complete. Besides the pictures of the principal celestial objects and portraits of the directors of the Paris Observatory, the hall contains a number of objects connected with astrology as well as astronomy, and a number of historical instruments, as the bar which was used for measuring the Peruvian degree, the similar instrument which was taken to Lapland by the Northern Commission; the pendulum used by Duperrey, and that used by Fraissinet for measuring the intensity of gravity in remote lands, the former being constructed by Fresnel; the bi-refracting prism used by Arago for his great optical discoveries, the portable meridian circle designed by Admiral Mouchez, &c., &c.

A solution of a problem which has lately acquired some celebrity, viz., *How to colour a map with four colours without colouring adjacent districts the same colour*, has just been obtained by Mr. A. B. Kempe, and will shortly appear at length in the *American Journal of Mathematics.* The fact that a map could be so coloured was stated by Prof. De Morgan to be well-known to map-makers, but no proof of the fact or means of solving the problem have hitherto, it is believed, been given. Some notion of the difficulty involved may be gathered from the fact that a very slight alteration in a map may render it necessary to recolour it throughout. Mr. Kempe's solution may be roughly described as follows:—He points out that every map must have a district in it with less than six surrounding it. This district he gets rid of by putting a patch over it which just projects over its boundaries, all boundaries which meet the patch being produced to meet in a point on the patch. A new map is thus obtained having one district less. This map must also have a district with less than six surrounding it which can be patched out in the same way. Continuing this process the map can at last be reduced to a blank sheet composed of overlapping patches. This can be coloured with a single colour. Stripping off the patches in the reverse order and colouring the districts as they are exposed, Mr. Kempe shows that whenever the 1, 2, 3, 4, or 5 districts surrounding a newly exposed one absorb all four colours, the colours can be rearranged in the map so as to reduce the surrounding colours to three, thus leaving a fourth for the exposed district. Thus successively taking off patches, rearranging the colours in the map, if necessary, and colouring the exposed districts, the whole map can be coloured. Mr. Kempe also shows *inter alia* that while the theorem is true in the case of globular surfaces as well as in that of maps, it does not hold in the case of such a surface as an anchor-ring.

We have received a copy of the second part of Mr. W. B. Hemsley's "Diagnoses Plantarum Novarum Mexicanarum et Centrali-Americanarum." We believe that the whole of the MSS. of the *Polypetalæ* of the botany of Messrs. Godman and Salvin's "Biologia Centrali-Americana," is now in the hands of the printer, and Mr. Hemsley is far advanced with the *Gamopetalæ*. The first part of the Polypetalæ will shortly appear. The publication of the Polypetalæ has been delayed, in order to include a very valuable collection made last year in the State of San Luis Potosi, Mexico, by Drs. Parry and Palmer.

A series of interesting experiments with the electric light commenced, by order of the authorities, at the School of Military Engineering, Chatham, on Thursday last. The experiments are for testing the relative qualities of the several inventions now in use in the Army and Navy, including Messrs. Wylde's invention (which has been fitted on board nearly all the larger ironclads in the Navy), Messrs. Siemens' invention, the Gramme light, and others. The experiments, it is expected, will last several weeks, and they will be carried out under the direction of Capt. Armstrong, R.E., instructor in telegraphy at the School of Military Engineering.

The Council of the Institution of Civil Engineers have recently made their annual awards, out of special funds bequeathed for the purpose, for approved original communications read and discussed at the weekly meetings during the past session, or printed in the "Minutes of Proceedings" without being read, as well as for papers submitted by students. From the Telford Fund medals and premiums have been bestowed on Messrs. G. F. Deacon, J. B. Mackenzie, J. N. Douglass, A. F. Blandy, E. Dobson, J. Price, J. E. Williams, G. W. Sutcliffe, E. Sang, W. G. Laws, and G. Higgin. The Manby Premium has fallen to Mr. J. P. Griffith. Miller Prizes have been adjudged to the following students:—Messrs. A. C. Hurtzig, R. H. Read, J. C. Mackay, and P. W. Britton.

The fourth marine excursion of the Birmingham Natural History and Microscopical Society to Falmouth, which extended from July 5 to 14, has proved a great success, and quite equalled, if not surpassed, the preceding ones to Teignmouth and the Island of Arran. A larger number of members than usual joined the party, which consisted of nine ladies and twenty-two gentlemen—a total of thirty-one. As hitherto the excursion was arranged so as to give facilities for the study of the marine zoology, botany, and geology of the district. For the former of these an admirable little steam tug, the *Albert*, was engaged. Land excursions were also arranged daily to interesting points, including the Land's End, the Lizard, &c. For the first time

the members had an opportunity of getting out into deep water of from forty to fifty fathoms, and a most interesting and valuable series of specimens was taken in all classes from diatoms up to fishes. The most noteworthy capture by the dredge in water of fifty fathoms off the Bay, was a specimen of the rare Alcyonarian zoophyte, *Virgularia mirabilis*. In the evenings the specimens taken were exhibited in the ladies' drawing room, some under the microscopes, under the superintendence of Mr. Marshall and Mr. Bolton. The botanists have not been idle, and nearly 400 species of flowering plants have been gathered, besides ferns of many species and varieties. A noteworthy circumstance connected with this excursion has been the kind assistance rendered by local naturalists, among whom are Mr. Howard Fox, the Rev. W. Rogers, Mr. Thomas Cornish, Mr. Tressidder, &c. Some valuable suggestions and encouraging remarks were also made in letters from eminent naturalists in special branches, viz., Prof. Allmann, Dr. Gwyn Jeffreys, Mr. P. H. Gosse, and Mr. H. J. Carter. On Thursday Mr. Saville Kent joined the party, accompanied the dredgings, and kindly rendered very valuable help. Full reports of the excursion will be presented to the Society in due course from the members who are going over the specimens; in marine zoology by Mr. Graham, the President, Mr. Saville-Kent, Mr. Wills, Mr. Trye, and Mr. Hughes; in botany by Mr. Baxenall and Mr. Morley; and in geology by Mr. Burman and Mr. Cotterell. Every effort was made for the comfort of the visitors by the obliging manager of the Falmouth Hotel, where the party took up their quarters, and the hon. sec., Mr. Morley, was indefatigable in his efforts to make the excursion successful. Not the least enjoyable part of the excursion was the really beautiful weather, which was fine and bracing during nearly the whole period. The twentieth annual Report of this Society speaks favourably of its progress, and the more active part taken by the members in its proceedings. Some consideration has been given to plans for utilising the energy of the Society in developing original research and knowledge of natural histology. Circumstances have interfered to prevent immediate action, but we hope that before long the Society will be able to carry its plan into execution.

AT the anniversary meeting of the Sanitary Institute of Great Britain the annual address was delivered by Mr. G. J. Symons, F.R.S., on "Water Economy." Mr. Symons, in the first part of his address, explained the circumstances which combined to render the small areas in the kingdom on which upwards of 75 inches of rain fell annually, of great national importance. Almost all these districts of heavy rain were districts of hard rocks, of steep slopes, and of sparse population. The first of these conditions insured the permanency of the physical geography of the district—the rocks being too hard to be washed away—and therefore the permanency of the rainfall; the second lessened evaporation, and sent the water rapidly into the streams or lakes; and the third tended to insure the purity of the effluent water. Having traced the water from the clouds to the earth, he next considered the effect of soil, crops, inclination of ground, &c., upon the water thus precipitated. He showed the necessity for modifying our customs and laws respecting rivers and watercourses, &c., in conformity with the advance of civilisation and the increasing population of the country. He recommended that the entire administration of streams should be under a single direction, which should see to all questions of drainage, sewerage, canalisation, motive power, and water supply. Such new works as were required promptly should only be authorised subject to their reverting to Government in fifty or a hundred years. All other hydraulic works should be undertaken, or at all events supervised, by a Government department, so as to insure the greatest possible public benefit and not merely that of an individual town.

MR. R. ANDERSON, F.C.S., whose paper on Lightning Conductors and Accidents from Lightning attracted considerable attention at the last meeting of the British Association, has for some time been engaged on a large work treating the subject from a scientific, practical, and historical point of view. The book is now nearly ready, and will be published in a few weeks.

WE have received from Mr. William George of Park Street, Bristol, the first four numbers of an interesting catalogue of works referring, *inter alia*, to geography, geology, chemistry, and other branches of science. The catalogue displays a considerable knowledge of the bibliography of these subjects, and would, no doubt, interest many of our readers.

AMONG Mr. Murray's announcements are: "The River of Golden Sand; a Narrative of a Journey through China to Burmah," by Capt. Wm. Gill, R.E.; "A Lady's Life in the Rocky Mountains," and "Japanese Letters," by Miss Isabella Bird; "A Sketch of the Life of Erasmus Darwin," by Dr. Krauss, translated from the German, with a preliminary notice, by Charles Darwin, F.R.S.; "Metallurgy, Part V., Silver and Part of Gold," by Dr. J. Percy, F.R.S.

THOSE of our readers interested in India may be glad to know that Mr. Quaritch has on sale the second edition of Balfour's monumental Cyclopædia of India.

M. W. DE FONVIELLE writes:—"On July 9 I made an ascent at Douay in a small balloon, at 5.30 P.M., with a strong west-south-west wind; velocity, 1 kilometre per minute. The temperature varied from 12° to 14° C. according to the exposure, and the altitude from 900 to 1,300 metres. From 800 to 1,000 were small floating clouds of irregular shape, not more than 100 metres in altitude and 200 metres in transverse dimension, but very dense, obviously formed with pure water, without any snowy matter. We observed at six different times the white rainbow, or Ulloa Circle, at the superior surface of this cloud. This dispels the notion, published in so many text-books, that it is seen only on icicles. There were three circles—interior blue, medium yellow, and exterior red. I had not a sextant for measuring the diameter, which I suppose was not more than 25 to 30 degrees for the exterior circle, somewhat less than the little halo, and in all cases about the same, irrespective of the distance of clouds. It was, of course, seen opposite the sun. The interior part was quite silvery white, being merely reflected light from the sun. The shadow of the car, travellers, and balloon was seen in the centre with angular dimensions varying according to the distance of the clouds. The shadow was sometimes projected outside the luminous circles, being too large to be included. Once we saw distinctly a luminous circle developing round the balloon, and we had two coloured images at once. The balloon phenomenon did not last long enough to be carefully observed; it appeared less distinct. I recollect only the reddish part of it, but we are both certain of its appearance. I suggest the acceptance of the explanation given by Bravais of the white rainbow, that it is produced by the reflection of the sun's rays on the surface of small vapoury vesicles, composed of a little quantity of air imprisoned by a shell of water. I noted also a curious optical illusion of a kind which was indicated to me by Mr. Coxwell a few years ago. When the clouds were at some distance they appeared almost at the same level, and I was under the impression that the balloon was ascending as they were passing under the car at some distance below. But the barometer and other circumstances proved we were keeping almost a perfect vertical equilibrium, and travelling in a horizontal direction."

W. B. F., writing from Point-of-Air, North Wales, on the 14th inst., states that an earthquake was observed there that morning at 1.5 A.M. The direction of the undulation appeared to be from a little to the east of south to a little to the west of

north. The movement of the earth was plainly felt by several persons in the neighbourhood. Previous to the shock the night was clear, warm, and calm, with a slight air from the south-west; twenty minutes after the shock there was a thunderstorm, accompanied by very heavy rain.

FROM a statement in the House of Commons by the Under-Secretary of State, it seems that the distribution of the Indian Museum collections has not yet been determined on, and is the subject of investigation by a committee in communication with the authorities at the British Museum, South Kensington, and Kew Gardens. The main object which is expected to be gained by this step is the increased utility of the collections to the public. The Economic Section, for instance, it was stated, could be maintained and perfected with great public advantage in the experienced hands of Sir Joseph Hooker at Kew, where he already has a far better collection of similar objects; while as regards the zoological, ethnological, and art collections, their transfer to departments where they will be more generally seen and appreciated, seems better than to retain them in a museum which, somehow or other, does not attract visitors. The fact that 9,000*l.* a year will be saved to the Indian revenues, may not have been without weight in deciding to break up the Museum.

THE *Daily News* New York correspondent telegraphs as follows :—"Mr. Edison has partially overcome the obstacle to his electric light offered by the high price of platinum. His lamps, instead of costing several dollars apiece, as at first, can now be made of an alloy of platinum with inferior metals, so as to cost only fifty-six cents. He announces that he can now produce the spiral coil for incandescence at a price which all who use gas can easily afford, and that his efforts to find platinum are only induced by the desire to reduce the cost of burners still further."

No. 27 of the *Journal* of the Society of Telegraph Engineers contains an important paper, by Col. Bolton : "Some Historical Notes on the Electric Light," consisting of abstracts from all the English patents on dynamo- and magneto-electric machines and on electric lights, classified and arranged in subdivisions according to the special class feature of each form of machine or lamp. From these abstracts it will be seen that several of the so-called new inventions on this subject that have been attracting so much attention of late are really inventions of long ago.

IN recent researches (described to the Vienna Academy) on the specific viscosity of liquids and its relation to chemical constitution, Herr Pribram and Herr Handl have observed (1) that the substitution of Cl, Br, I, and NO_2 for H in a molecule, caused, in all cases examined, an increase in the time of flow (through a capillary tube); (2) that this increase was least on substitution of Cl, and more, successively, in those of Br, I, and NO_2; (3) that for the absolute value of increase of the time of flow, not only the quality of the element introduced, but also its position in the molecule, is a determinant.

ACCORDING to Prof. Du Bois Reymond, grave sounds should be more weakened by telephonic transmission than acute sounds (causing an alteration of *timbre*), but all sounds, whatever their pitch, suffer a retardation of a quarter of a wave. On the other hand Prof. Helmholtz, by a theory apparently more complete, finds that all sounds are weakened nearly in the same proportion, and that the difference of phase introduced must be very small. M. Koening has recently made experiments with a view to decide the question. He substitutes two tuning-forks, A and B, for the membranes of two associated telephones, and vibrates A with the bow; at once B enters into vibration, and one may, either by observing successively with an optical comparing instrument, the vibrations of A and B, or by arranging A and B as in the well-known experiment of M. Lissajous for composition of rectangular vibratory movements, measure the difference of phase of the tuning-forks, which is found exactly equal to a quarter of a wave-length. An experiment on complex sounds was made by changing one fork Ut_1 for fork Ut_4 so as to produce simultaneously the sounds 1 and 8 before the bar of a telephone. The difference of phase was still found equal to a quarter of a wave. Thus Du Bois Reymond's view is more in accord with experiment than that of Helmholtz.

ACCORDING to Herr Kohlrausch (*Ann. der Physik*, No. 6) well-defined tones may be produced in a simple way by only two impulses. Place two fingers of the hand loosely together, so that the end of the nails are about on a level, and then tap gently on the table, the proper tone of this having been deadened as much as possible by means of books, or sitting on it, or otherwise. It will be readily felt that the two fingers seldom strike quite simultaneously, and with some attention one may hear (best if the tapping be repeated twice or thrice in a second) in addition to the noise, of indeterminate pitch, a very bald tone of pitch varying at first with the position of the fingers, but which, after a little practice, one can approximately fix. It is also possible to give a musical interval by tapping twice with the fingers differently adjusted; Herr Kohlrausch says he has often perceived differences of pitch to the extent of a semitone. Within the interval 15 : 16, then, the tones of only two impulses can be accurately determined. Tapping with only one finger-nail these tones entirely disappear; and one may therefore easily learn to hear them by tapping alternately with the one and with the two fingers.

IN a recent paper to the Belgian Academy M. Renard endeavours to fix the distinctive characters of calcite and dolomite in rocks which contain these two elements associated in microscopic individuals. After showing that the characters on which the distinction has been established hitherto are not satisfactory, he substitutes the character which dolomite has of appearing nearly always with the form of the original rhombohedron, whereas calcite never, one may say, affects this crystalline form. It results from his observations that the dolomites which do not belong to the normal type must be considered as mechanical mixtures of dolomite and calcite, and not as combinations in which the excess of one of the two constituent bases must be interpreted according to the laws of isomorphism. M. Renard supports his determinations by chemical researches under the microscope, and, in concluding, he points out that in the case of several dolomitic rocks of carboniferous limestone, the dolomitisation is due to an action posterior to the sedimentation of the calcareous elements.

WILLUGHBY, not Willoughby (as printed in last week's NATURE) is the name of the new society for reprinting scarce ornithological works, which takes its name from Francis Willughby, the pupil and patron of John Ray, who first edited and then translated his "Ornithologiæ Libri tres," besides his ichthyological works.

THE International African Association have just published a note by Dr. Dutrieux, of the Belgian African Expedition, on the subject of a parasitical cutaneous affection which he has had opportunities of observing during his journey. The parasite especially attacks oxen, whence it is called *founza ia ngômbé* (ox-worm). The negroes suffer a good deal from it, and it appears to burrow into different parts of their feet. When it is extracted, in consequence of their always going barefooted, they get very painful ulcers, which Dr. Dutrieux says are exceedingly difficult to cure.

THE new number of the *Indian Forester* contains a paper of much interest on the Banda Forests, and the continuation of another on the function of the pines and the larch in the production of soil. There is also a letter which furnishes some curious notes

on the coppicing powers of certain trees in dry and arid climates.

THE *Annual Report* of the Society of Arts for 1878-9, shows, as might be expected, that during the past session, a vast amount of good and useful work has been done under its auspices. As to the material condition of the Society the report is favourable, notwithstanding the badness of the times.

THE Report of the Auckland (N.Z.) Institute for 1878-9, speaks of the steady progress of the Society, and the increasing interest manifested by the public in its operations. Several valuable papers on New Zealand natural history have been read.

WE have received a number of little Guides for Science Teaching, issued by the Boston (U.S.) Society of Natural History. The enterprise is creditable to the Society, and the "Guides" seem to us to be handy and trustworthy. Some of them are reprints and second editions. They are—"About Pebbles," by Alpheus Wyatt; "Concerning a Few Common Plants," by G. L. Goodall: "Commercial and other Sponges," by A. Wyatt; a reprint of Mrs. Agassiz's "First Lesson in Natural History;" "Common Hydroids, Corals, and Echinoderms," by A. Wyatt. The last three are very fully illustrated.

WE have received from Mr. J. T. Peacock, the eminent grower of succulent plants, a list of the plants cultivated by him; these comprise cacti, agaves, yuccas, sempervivums, euphorbias, and in fact all plants of a succulent or fleshy nature, many of which have hitherto been much neglected by cultivators. The extent of Mr. Peacock's collection may be judged from the fact that at the present time portions are contained at Sudbury House, Kew, the Alexandra Palace, and the Botanical Gardens, Regent's Park. For the purpose of making this class of Plants more generally appreciated among amateurs Mr. Peacock intends sending the printed list to applicants who send an addressed halfpenny wrapper to Sudbury House, Hammersmith.

THE *Allgemeine Zeitung* reports important anthropological discoveries in Moravia. Excavations have been going on for some months back under the direction of Herr Carl Maschka, a specialist in these subjects, in the Shipka and Tschertowa Dira caves, near Stramberg. The discoveries, it is stated, have been made in layers, carrying the investigator back step by step to the palæolithic age. Stone and bronze weapons, with bones of a variety of animals belonging to different periods, appear to have been found in large numbers.

OWING to the great cost and often very inferior quality of gas, the *Colonies and India* states that for street lighting the electric light is coming into favour in many parts of Australia, and in South Africa particularly; and when the problem of subdividing the light for use in small houses is satisfactorily solved, it will find a wide field in which it can establish itself more rapidly than will be the case in England.

A JAPANESE paper states that some chemists have discovered a vein of silver at Yuigahara, in Kioto-Fu. The water of a pond in the neighbourhood being discoloured, their curiosity was excited as to the cause, and a search for minerals in the vicinity resulted in the discovery mentioned.

FROM the Third Annual Report of the Burton-on-Trent Natural History and Archæological Society, it seems to be in a prosperous condition. It forms one of the Midland Union of Natural History Societies, and the work it is doing is on the whole creditable.

THE additions to the Zoological Society's Gardens during the past week include two Crested Porcupines (*Hystrix cristata*) from West Africa, presented by Mr. Moses Boyle; a Black-winged Peafowl (*Pavo nigripennis*) from Cochin China, presented by the Hon. A. S. G. Canning, F.Z.S.; a Buff-backed Egret (*Ardea russata*), European, six Small-scaled Mastigures (*Uromastix microlepis*) from Busreh, presented by Capt. Burke, s.s. *Arcot*; a Gold Pheasant (*Thaumalea picta*) from China, presented by Mr. J. E. Liardet; two Common Barn Owls (*Strix flammea*), European, presented by Mr. R. A. Baldwin; an Indian Python (*Python molurus*) from India, a South American Rat Snake (*Spilotes variabilis*) from South America, presented by Mr. George Billett; two Elliot's Guinea Fowls (*Numida ellioti*), four Vulturine Guinea Fowls (*Numida vulturina*) from East Africa, deposited; a Striped Hyæna (*Hyæna striata*) from India, a Yellow-footed Rock Kangaroo (*Petrogale xanthopus*), four Black Swans (*Cygnus atratus*) from Australia, two Balearic Cranes (*Balearica pavonina*), four Rose-ringed Parrakeets (*Palæornis docilis*) from West Africa, two Siamese Pheasants (*Euplocamus prælatus*) from Siam, a Darwin's Pucras Pheasant (*Pucrasia darwini*) from China, purchased; a Japanese Deer (*Cervus sika*), born in the Gardens; three Australian Wild Ducks (*Anas superciliosa*), a Spotted-billed Duck (*Anas pœcilorhyncha*), six Rosy-billed Ducks (*Metopiana peposaca*), bred in the Gardens.

HOLLWAY'S NEW APPLICATION OF RAPID OXIDATION BY WHICH SULPHIDES ARE UTILISED AS FUEL[1]

THIS process has for its object the utilisation of the heat generated by the rapid oxidation of certain mineral substances, which have not hitherto been used as sources of heat for smelting operations. The heat thus obtained is employed in the reduction of the furnace charge, which may be composed partly of sulphides and partly of siliceous ores. A current of air is forced through molten sulphides, by which means they are very rapidly oxidised. Great heat is thus developed, rendering the process of smelting a self-supporting operation; therefore no extraneous fuel is required, excepting that employed in raising steam for the blowing engines; where, however, water power is available, steam can be dispensed with, in which case all the carbonaceous fuel necessary for the operation is a little coke to start the furnaces, which stands in the same relative position to the ores as wood does to coal in the lighting of an ordinary fire.

It is well known that pyritous minerals are readily combustible, but the best means of utilising the heat-producing property of metallic sulphides is not so apparent as would at first sight appear. Of these sulphides only iron pyrites is sufficiently combustible at a low temperature to burn in the open air, the mass being raised to the temperature at which the oxidation takes place solely by the union of sulphur and iron with atmospheric oxygen. In Spain there are numerous deposits of poor cupreous pyrites, and the Rio Tinto and Tharsis Companies annually treat, at their mines, about one million tons for the extraction of copper only, which does not average 2 per cent. The process employed consists essentially in roasting the pyrites in heaps in the open air, dissolving out the copper from the roasted material, and precipitating it from the solution by means of iron. These operations extend over several months; any gold or silver contained in the ore is lost, and the iron and sulphur are also wasted. The sulphur passes into the air as an obnoxious and annoying gas, desolating the country for miles around the works.

From the earliest ages, carbon has been considered a necessity in all metallurgical operations. The first reduction of metals by means of carbon forms a connecting link between the age of stone and the commencement of civilised art. It is well known that carbon burns at widely varying temperatures, as, for example, in our bodies, in a common coal fire, or in a furnace. A great deal of thought has been devoted to the subject of economising carbonaceous fuel, and great advances have been made in this direction; yet the expenditure of coal or coke necessary, say, to melt a given quantity of metal, still far exceeds the theoretical limit. The main causes of this discrepancy may be accounted for as follows:—

1. Only part of the oxygen of the air passing into a furnace, acts on the material to be burnt.

2. The oxygen is not brought in contact with the combustible matter with sufficient rapidity, to obtain the necessary temperature for the operation.

3. Gases pass off hot and unburnt. These are now, however, frequently utilised.

[1] Communicated by Mr. Hollway.

There is one metallurgical operation in which the first two sources of loss are avoided, viz., "Bessemer's," where, by blowing air through molten crude iron, a very high temperature is attained by the combustion of small quantities of carbon and silicon contained in the crude iron; this is, however, not the case in the process of puddling, where the oxidation is spread over a considerable period of time, although the same constituents are frequently burnt in similar proportions. But even in the Bessemer process the carbon is only half burned, and a large amount of heat escapes with the carbonic oxide and nitrogen.

When, however, thin streams of air are forced through molten sulphide of iron, lying on a tuyère hearth, a high temperature is produced by the perfect combustion which ensues in the midst of the sulphides, and no unburnt gases, excepting nitrogen and sulphur vapour, escape from the surface of the molten mass. The hot nitrogen and sulphurous acid may be caused to act upon iron pyrites and other mineral matter, and when pyrites is thus heated, an atom of sulphur held in feeble combination is in great part expelled, and thus is obtained molten protosulphide of iron, which is subsequently burnt by the oxygen of the air driven in at the lower part of the furnace, thereby producing the heat necessary for continuing the operation. The process may be defined as a system of fractional oxidation, in which the numerous constituents of a complex furnace charge can be separated from each other and concentrated in different parts of the apparatus, the heat necessary for the operation being obtained by the combustion of a portion of the less valuable constituents.

The principal ores of all our ordinary heavy metals, except manganese and tin, are sulphides. Iron, although largely occurring in an oxidised form, is abundantly found in combination with sulphur; and bisulphide of iron, or iron pyrites, is an example of sulphurous and combustible minerals. Associated with iron and sulphur in iron pyrites are invariably found small quantities of other metals, notably cobalt, nickel, copper, silver, gold, lead, zinc, and arsenic. Of these, zinc is almost as combustible as iron itself, while lead and arsenic readily volatilise as sulphides, and cobalt, nickel, and copper are distinctly less readily oxidisable than iron, while silver and gold do not oxidise under these conditions; hence, in supplying air to such material, the iron is the first of the elements to suffer oxidation, so that if the oxidation be arrested before the whole of the iron has been burnt, the cobalt, nickel, copper, silver, and gold present will be found in the unburnt portion. This principle finds a parallel in the Bessemer process of treating pig-iron for the manufacture of steel, where a current of air is caused to bubble up through a bath of molten crude iron, [the silicon is first oxidised, and is closely followed and to a great extent accompanied by the carbon, and no large amount of iron suffers oxidation, until the whole of the silicon and carbon have been burnt out of the molten material.

The experiments made at Messrs. Cammell's works, at Penistone, in a Bessemer converter, have proved that by blowing air through molten sulphide of iron, the iron and a portion of the sulphur are oxidised, and if the oxidation is arrested before the combustion of the iron is complete, a heavy matt or regulus is obtained, which contains but a small proportion of the iron of the ore, but practically the whole or the greater part of the copper and other less oxidisable metals. In one of these experiments the molten sulphides were run into the converter from a cupola, in which they had been previously melted, and the temperature was kept up until the operation was discontinued, viz., for a period of ten hours, without the use of any carbonaceous fuel, the heat being entirely derived from the oxidation of the iron and a portion of the sulphur of the lumps of pyrites, which were continuously thrown into the mouth of the converter. A Bessemer converter being unsuited for the collection of the gaseous products, the later experiments have been made in a series of cupola furnaces belonging to Messrs. John Brown and Company, Limited. These experiments have proved the possibility of obtaining a valuable regulus, a slag nearly free from copper, and a considerable quantity of crude sulphur. M. Pourcel, the well-known chemist of the Terrenoire Company, has also made some very interesting experiments, having treated by this method a cupriferous sulphide of antimony containing lead and zinc, using heavy spar and silica as fluxes; he obtained a regulus containing the whole of the copper in the form of sulphide, a slag of light specific gravity, and the lead, zinc, and antimony as two separate sublimates which were condensed in different parts of the apparatus, owing to the superior volatility of sulphide of lead over the oxides of antimony and zinc. In the experiments at Penistone and at Sheffield a cold blast of air was employed, and the gases which passed from the converter or furnace into the open air, carried away with them a large amount of heat. In practice, however, it would be economical to employ a hot blast, which could be heated by the waste heat from the escaping gases. It is remarkable that the least valuable metals, viz., iron and zinc, generate by their combustion the largest quantities of heat.

The process may be employed for the reduction of even the more volatile metals; for example, Mr. A. H. Allen, of Sheffield, has thus obtained metallic antimony simply by the oxidation of sulphide of antimony. It is well known that sulphide of lead reacts upon oxide of lead with the production of metallic lead and sulphurous acid. If, therefore, a limited amount of air is blown into molten sulphide of lead, the oxide thus formed in the lower part of the furnace will, in passing upward, come in contact with the hot sulphide of lead, and metallic lead will result, with the evolution of sulphurous acid. The furnace having a quiescent hearth below the tuyères, the metallic lead will collect there, and can be from time to time withdrawn. A limited amount of air must be employed, because if it is driven in too quickly, the sulphide of lead will rapidly distil off. In thus treating argentiferous lead ores, the silver (and gold if present) would be found with the first metallic lead reduced. When thus treating galena the furnace should have a basic lining.

The process is peculiarly suitable:—

1st. For the treatment of metalliferous substances which cannot be advantageously treated by other processes. For the extraction of sulphur by distillation, and simultaneously for the concentration and separation of cobalt, nickel, copper, silver, and gold from minerals in the form of metallic regulus; while lead, zinc, antimony, arsenic, &c., accrue in the sublimates.

2nd. For the treatment of complex ores, for example—Grey antimonial copper ores, such as those experimented on by M. Pourcel. Ores similar to those worked at the well-known Bottino Mines, Seravezza, in the Italian Apennines, which contain thirteen or fourteen heavy metals, including silver and lead, for which latter alone they have been worked for centuries. The blende of lead mines, in Derbyshire termed "muck," usually thrown away by the miners, because the large quantity of lead with which it is associated renders the zinc obtained from it worthless.

3rd. For the treatment of auriferous and argentiferous pyrites. It is well-known that in practice it is not possible to obtain the whole of the gold from pyrites by amalgamation with quicksilver, because the presence of sulphur and arsenic sickens and flours the mercury, whereas by fusion the whole of the silver and gold present is obtained.

4th. For the treatment of pyrites containing even only small percentages of cobalt, nickel, and copper, which are thus concentrated into a rich regulus, whereas this result is now only obtained by very tedious processes of alternate roasting and reduction. Such ores containing 10 per cent. and even 12 per cent. of copper exist in South America and many other parts of the world, but are not at present capable of economic treatment, owing to the difficulty of obtaining a sufficient supply of cheap fuel. The process can also be advantageously applied to the treatment of richer ores of copper such as are at present smelted at Swansea.

5th. For the treatment of poor lead ores. If such ores are added to a furnace charge of cupreous pyrites, the silica they contain will be utilised and combine with the resulting oxide of iron to form slag, the galena will be volatilised and be recovered as a sublimate, while any silver present will enrich the regulus. At present, by a costly process of crushing and washing these ores, the galena is concentrated, although a large proportion is left with the *débris*, and passes with the water into the streams, rendering the existence of fish in such waters impossible. The water power now used for washing the ore could, in many cases, be employed for producing the blast.

When thus treating cupriferous iron pyrites, four products are obtained:—

1st. A matt or regulus containing from 30 to 50 per cent. of copper, any traces of cobalt, nickel, silver, or gold the ore may contain, the rest of it being iron and sulphur; it has a specific gravity of 4½ to 5.

2nd. A slag consisting of silicate of iron from the resulting oxide of iron combined with the siliceous matters contained in the ore and the fluxes added.

3rd. Sublimed sulphur, more or less mixed with volatile compounds of lead, zinc, and arsenic.

4th. Sulphurous gases, consisting mainly of sulphurous acid and nitrogen.

The regulus closely resembles, and will replace, the coarse metal of the Swansea copper process, which is now only obtained at considerable cost of labour, time, and carbonaceous fuel. When, however, sulphides of iron and copper present in the bath are treated continuously by a blast of air, a point is at length arrived at when the whole of the iron is oxidised, and the regulus in the bath consists of sub-sulphide of copper. If, now, a limited supply of air is introduced, the copper is reduced to the metallic state with the evolution of sulphurous acid.

The slag obtained in the Penistone experiments was essentially silicate of iron, containing about 50 per cent. of iron and 29 per cent. of silica. It had a density of about 3 8 to 4, and was in composition somewhat allied to the copper-smelter's ore furnace slag and to the tap-cinder of the iron-puddler. By the addition of calcareous materials, the specific gravity of the slag is so reduced as to cause it to separate readily from the regulus which collects below it. In one of the later experiments, when lime was used, the proportion of copper lost in the slag was very small. This is, of course, a most important point, for when dealing with ores containing but little copper, the presence of even a small percentage in the slag means the loss of a considerable proportion of the copper present. These slags can be utilised for the manufacture of steel, being practically siliceous iron ores free from phosphorus, and their reduction in a blast furnace can be profitably effected, as the proportion of iron present is high as compared with the weight of the material; indeed, it may be possible to reduce them while in a molten state.

By re-subliming the crude sulphur, it can be freed from all impurities except arsenic, and at the works of Messrs. John Hutchinson and Co., Widnes, this is eliminated by means of polysulphide of calcium.

As a certain proportion of the sulphur of the minerals suffers combustion, the resulting sulphurous gases contain from 14 to 15 per cent. of sulphurous acid, and hence the proportion of sulphurous acid to nitrogen is nearly identical with that of the gases produced by roasting pyrites in the kilns employed by vitriol manufacturers, and can, therefore, be used with equal advantage for the production of vitriol in leaden chambers. This appears to be the simplest solution of the great problem how to smelt copper without causing a nuisance to the surrounding neighbourhood, although a similar result might be obtained by collecting and liquefying the sulphurous acid.

The more incombustible materials it is found practicable to employ without too great a loss of temperature, the wider will become the application for the process; for there are many ores, including silicates and carbonates, containing metals in the form of oxides, which might be conveniently smelted by mixing them with a sufficient proportion of pyritous ores to effect their reduction; in fact, one of the chief practical questions connected with this process is how far it may be trusted to effect the smelting of ores or furnace charges containing comparatively moderate proportions of sulphides. It is evident that it will almost entirely obviate the necessity for using carbonaceous fuel, at least as far as the production of a regulus is concerned, and consequently the localities in which smelting operations may be advantageously carried on are thus greatly multiplied. One of its chief merits is that it is equally applicable with comparatively little extra cost in the working, to very poor and very rich ores, for however small the resulting regulus, it will contain nearly the whole of the cobalt, nickel, copper, silver, and gold present in the furnace charge, while any lead, zinc, antimony, and arsenic will be obtained as sublimates.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE authorities at Owens College, Manchester, and of the Yorkshire College of Science, Leeds, have already taken the initiatory steps for preparing a constitution of the new University for the North of England, for which a charter has recently been granted. The Council of the Owens College have appointed a committee of their body, and on Friday they met in conference at the college in Manchester, with representatives of the Council of the Yorkshire College of Science, for the purpose of considering a draft constitution for the new institution. The basis of the deliberations of the conference is to be found in the series of suggestions contained in an appendix to the memorial which was presented to the Privy Council some time ago, but various questions will come before the meeting for consideration, including the power of granting degrees to women and the better representation of the graduates and the teaching staff upon the Board of Governors. Considerable progress was made on Friday in preparing suggestions for a draft of a proposed charter, though each of the clauses was very fully discussed before adoption. When the conference has completed its task it will report to the Council previous to the scheme being submitted to the Law Officers of the Crown.

MR. W. N. HARTLEY, of King's College, London, has been appointed Professor of Theoretical and Practical Chemistry in the Royal College of Science, Dublin, and enters upon his duties at the beginning of the October term.

THE following students have passed the examinations which entitle them to the distinction of "Associate of the Royal School of Mines":—In the Mining and Metallurgical Divisions: Mirza Mehdy Khan. In the Mining Division: W. E. Benton, A. G. Charleton, A. D. Ellis, E. N. Fell, H. B. Statter, H. Strickland. In the Metallurgical Division: W. B. M. Davidson, A. H. Fison, F. W. Grey, E. Halse, E. W. Harvey, Malcolm Hill, J. H. Lucas, Walter Marsh, A. Gordon Salamon. The two Royal Scholarships of 15*l*. each have been awarded to J. J. Hood and J. F. Wilkinson. The Royal Scholarship of 25*l*. has been awarded to Ralph G. Scott; the De la Beche Medal for Mining to A. D. Ellis; and the Murchison Medal for Geology to B. Mott.

SCIENTIFIC SERIALS

American Journal of Science and Arts, June.—Reviewing what is now known of extra digits in the feet of the modern horse Prof. Marsh says the instances fall naturally into two groups: the first comprising simply cases of reduplication (like that of the occasional extra-finger in the human hand), not satisfactorily explained as yet; the second includes cases where a true digit is formed, the component bones in normal position and relation, and such instances seem clearly due to reversion to some ancestral type. Extra digits appear more frequently on the fore feet than the hind feet (as a study of fossils would lead one to expect), and more frequently on the inside of the main digit, the outer splint remaining rudimentary (this, again, is opposed to the general law of reduction in the ungulate foot).—Mr. Sargent's paper on the forests of Central Nevada has been elsewhere referred to, and we further note that Prof. J. C. Draper writes on the dark lines of oxygen in the solar spectrum on the less refrangible side of *G* (in the regions about λ 4317 and λ 4319); Mr. Christy seeks an answer to the question "Are cinnabar deposits produced by sublimation, or are they deposited from solution?" and concludes that they are the immediate result of the action of solutions of alkaline carbonates containing also alkaline sulphides; Mr. Hodges suggests a new absolute galvanometer.—Mr. Sawyer contributes a first catalogue of radiant points of meteors (from observations at Cambridge during the last two years); and Maria Mitchell notes on the satellites of Saturn.—A recent paper published in Brazil, by Mr. Derby, on the geology of the Lower Arizonas, is summarised by Mr. Rathbun.

Journal of the Franklin Institute, June.—We note here the following:—Peaucellier's compound compass and other linkages, by Prof. Marks.—Some experiments on alloys of silver with embrittling metals, by Mr. Outerbridge.—Phosphorus in coal, by Mr. McCreath.—On the determination of silicon in pig-iron and steel, by Dr. Drown.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti. Vol. xii. fasc. xi.-xii.—On an integral formula, by Prof. Beltrami.—On tetrahedral systems, by S. Aschieri.—Atrophy and degeneration, by Prof. Sangalli.—On a parasite Colothurnia of the branchiæ of our crabs, by Prof. Maggi.—A microphyte on Hesperideæ, by Dr. Cattarneo.—The infirmity of Torquato Tasso, by Prof. Conadi.—A new bird for the Lombardy fauna, by Prof. Pavesi.—On the centre of forces in the plane, by Prof. Bardelli.—On the cortical iridian centre in birds, by S. Ortel.—New series of researches on the pelagic fauna of the Italian lakes, by Prof. Pavesi.

SOCIETIES AND ACADEMIES

London

Royal Society, June 19.—"Preliminary Note on a New Tide-predicter." By E. Roberts, F.R.A.S. (*Nautical Almanac Office.*) Communicated by Prof. G. G. Stokes, M.A., Sec. R.S., &c.

The Indian Survey Department having undertaken the superintendence of tide-registration around the whole sea-board of India and at the port of Aden, and also the reduction of the observations by the method of harmonic analysis, with the view to the prediction of the tides for the whole of the ports, it became a matter of necessity, in order to save the large outlay which the numerical operation of their prediction would have involved, that an instrument should be constructed to delineate the predictions.

Accordingly, on the recommendation of the Surveyor-General of India, I was desired to design, and to undertake the construction of, an instrument to include a sufficient number of tide-components to predict the Indian Ocean tides with all the accuracy necessary for practical purposes.

The present machine is the outcome of the recommendation.

The instrument combines the following twenty tide-components:—

The mean lunar semidiurnal;
The first and second overtides of the mean lunar semidiurnal;
Two *elliptic* lunar semidiurnal;
Two *evectional* lunar semidiurnal;
One *variational* lunar semidiurnal;
The mean solar diurnal;
The mean solar semidiurnal;
The lunisolar semidiurnal;
The lunisolar diurnal;
The lunar diurnal;
The solar diurnal;
One lunisolar elliptic diurnal;
One lunar elliptic diurnal;
One compound (Helmholtz) lunisolar semidiurnal;
One compound (Helmholtz) lunisolar quarter-diurnal;
The solar annual; and
The solar semiannual.

Strictly speaking, there is no sensible astronomical tide-component of twenty-four mean-solar hours' period, but for the purposes of prediction it is necessary to include such a term, a very regular and sensible result of this period being obtained in the analysis, due probably to wind or temperature. The same remark applies partially to the solar annual and the solar semiannual, the theoretical tides of these periods being very small; the analysed results, however, are of considerable value, being due probably to the effect of rainfall and the regularity of the monsoons. These three components should, therefore, be regarded more as meteorological than astronomical.

The stipulation that the scale for heights should be one inch per foot range for Bombay necessitated a recording barrel of some 18 inches at least; the actual length adopted for the instrument, however, is 22 inches. The delineation of the curves on such a large scale rendered necessary some modification of the system of excentric pulleys, as fitted on the tide-predicter of the British Association. It was at first contemplated to fit parallel slides only to the larger of the tidal components; the whole of them have, however, been so provided.

The chief difficulty in the construction of the machine is the finding, within reasonable limits, of proportions which shall represent with sufficient accuracy the periods of the several components, in order that the machine may be used for a considerable period of prediction—say, for twelve months. Very great success has been attained in this respect in the present instrument. For instance, the error of the period of the chief component (the mean lunar semidiurnal) relatively to the mean solar semidurnal is inappreciable during a whole year's predictions, amounting to about $0^{\circ}\cdot10$ only in a period of fifty years. The largest deviation from strict accuracy is $0^{\circ}\cdot37$, after a run representing twelve months. This is, however, of one of the very small components, and insensible in its results. This part of the design may be therefore regarded as practically perfect.

Each component is provided for setting with a crank, in which a sliding piece is fitted, carrying a steel guiding-pin. The guiding-pin is thrown out by means of a fine-cut screw and micrometer head. An improved parallel slide, carrying a pulley, is also fitted to each component. The guiding-pin works between two parallel adjustable steel jaws at the back of the pulley frame. The pulley frame is fitted with a balance-weight, so that its centre of gravity is in a vertical line through the pulley's axis. The whole slide is counterpoised by a cord and weight, passing over pulleys, in order to relieve the guiding-pin of all strain and to prevent wear. The steel bar of the pulley slide moves freely in two guides drilled out nearly their entire length to reduce the touching parts to a minimum. The other side of the pulley slide is kept in position by a projecting fork or guide, travelling with freedom along a narrow flat brass bar. Both the brass bar guide and the steel rod guide are divided to millimetres; the brass bar for approximate, and the steel rod for the accurate, adjustment of the throw of the crank-pin, for which purpose the upper guide of the steel rod is furnished with a vernier. The milled head of the micrometer-screw is also divided and may be used with the divisions on the brass bar guide. The pulley frame is movable on its steel rod, for the purposes of the perfect adjustment of the pulley about the centre of motion of the axis of the crank.

The axis of the crank carries behind the main plate a fine-toothed wheel, fitted on a slotted cone, with a milled nut for clamping the wheel on its axis. The toothed wheel is driven by an endless screw, carrying a bevelled wheel, which is itself driven by another bevelled wheel on one of the four main axes of the machine. The endless screws and main axes are fitted with counter pivots.

At the back of the machine are fitted the setting dials. Each dial is toothed round its outer edge and movable round its centre by a pinion for adjustment. The axis of the component projects through the setting dial, and carries a steel pointer for setting.

A fine flexible wire fixed to a large screw-head passes alternately under and over the pulleys of the lower and upper series of components, and carries an ink-bottle at its free end. The ink-bottle, fitted with a fine glass point, travels in a geometrical slide, and is suspended to give just sufficient pressure to ensure contact on the paper of the recording barrel.

The recording barrel is fitted with brass pins at equidistant intervals to form the time indications on the paper by perforation. An index for setting is fitted behind the machine at the top of the recording barrel.

The paper, which is continuous and supplied from a reel, passes round two grooved rollers at the back of the main barrel, and is held in position whilst the pins enter the paper, and after receiving the curves is wound round the haul-off drum. The haul-off drum rests on toothed driving-wheels, and by friction turns and slips to accommodate itself at a proper tension to receive the recorded paper. Motion is given to the whole system of wheelwork through the horizontal centre main shaft from a system of clockwork driving-gear at the bottom of the machine, the whole being driven by a weight calculated at about 4 cwt., and controlled by a fan. A warning bell sounds when the weight is nearly run down. The length of the barrel round which the cord is wound is sufficient to give 15,000 turns of the main shaft. This corresponds to about three months' run of curves, and will occupy about one hour to run off. A year's tide-curves for any port will thus occupy about four hours.

The setting of the machine for the prediction of the tide-curves of any port for which the tide-components are known is as follows:—The dials are first turned so that the epoch or time of maximum is exactly under or above the highest or lowest point according as the component is situated on the upper or lower row of components. The cranks are set vertically (the slotted cone of the wheel on the axis having been first released) and the guide-pin thrown out to its proper range to represent the half-amplitude of the component. The proper positions of the hands having been previously determined by calculation for the time of starting, the hands are set and the slotted cones tightened up. The recording barrel is then set to the time and the wheelwork set in motion. The complete setting occupies only a few minutes.

The large dial in the centre is for showing the progress of the record, which can be marked occasionally to facilitate the entry of the dates on the record after its removal from the machine. A few supplementary pins are inserted in the barrel for the better distinction of the hours. Two speeds of travel can be given to the paper, viz., 1 inch and ½ inch per hour. A fixed rod near the recording pen carries ruling pens for the tracing of base lines, such as dock sills, river bars, or mean tide-levels, or if desired can rule the paper throughout its entire depth to represent feet, metres, &c.

To Sir William Thomson my thanks are due for the improved parallel slide and other details, and also to Mr. Légé (the maker of the instrument) for the design of the wheel-gearing.

"The Motion of Two Spheres in a Fluid." By W. M. Hicks, M.A., St. John's College, Cambridge. Communicated by Prof. J. Clerk Maxwell, F.R.S., Professor of Experimental Physics in the University of Cambridge.

The investigation is based on the lemma that the image of a source in an infinite fluid in presence of a sphere consists of a source at the inverse point of the former, and a line sink thence to the centre of the sphere. From this is deduced the image of a doublet whose axis passes through the centre of the sphere, and of one whose axis is perpendicular to this. Thence is found the kinetic energy of motion of two spheres and fluid in which they are immersed, and properties of the motion deduced by Lagrange's eqnations. Amongst other things is considered the action between vibrating spheres.

Physical Society, June 28.—Prof. W. G. Adams in the chair. New Members: Mr. J. F. Moulton, Mr. J. J. Eastwick.—Prof. W. G. Adams exhibited his new measuring polariscope. It consists of three principal parts. The lower section consists of a mirror, a lens, a Nicol's prism, and two other lenses. The upper section consists of lenses and Nicol's prisms arranged in the reverse order. Each lens and Nicol's prism is supported separately by screws, and its position can be altered independently of the others. These two parts form a complete polariscope. Besides these there is a middle piece consisting of two lenses (nearly hemispheres) forming a box to inclose the crystal immersed in oils, their curved surfaces being concentric. The whole middle piece is supported on the tubes of the upper and lower portions, and may be turned about the optical axis of the instrument. The vertical graduated circle carrying the central lenses and crystal may be turned through any angle about its horizontal axis. By means of an arc fastened perpendicularly on the graduated circle with the centre at the centre of curvature of the central lenses, the crystal may be turned about another horizontal axis at right angles to the former, so that the crystal and the central lenses can be turned about each of three axes which are mutually at right angles. By means of a system of toothed wheels in gear with the rims of the central lenses, the crystal and central lenses may be turned separately about the optic axes of the instrument, so as to bring the planes of the optic axes of a biaxial crystal parallel to the plane of the vertical graduated circle.—Sir John Conroy, Bart., read a paper on the distribution of heat in the spectrum. After referring to Dr. J. W. Draper's supposition that all the rays in the spectrum have the same heating effect, and to his statement that owing to the unequal dispersion of the prism for rays of different refrangibility, the method that has been usual for determining the calorific intensity of the various parts of the spectrum is an essentially defective one; the author described a graphical method for eliminating the effect of the unequal dispersion of the prisms, and showed that from MM. Fizeau and Foucault's measurements, and also from those of Lamansky and Prof. Tyndall, that the maximum intensity is about the middle of the visible spectrum, and not at the red end; and, further, that the curves given by various observers as representing the intensity of the heat in different portions of the spectrum, are in reality the "dispersion curves" for the particular prisms employed.—Capt. Abney, R.E., called attention to his published paper on the measurement of the so-called thermo-spectrum, wherein he shows that the distribution of heat in the spectrum is a misnomer, and that what was really measured by Lemansky and Tyndall was the energy absorbed by the lamp-black and the absorption due to the prisms used. He considered that there was no inherent heat in the spectrum. He found that Dr. Draper had not taken into account the amplitude. Prof. Guthrie said that Capt. Abney had expressed what many thought, namely, that heat was radiant energy.—Mr. Grant then described an investigation which he had made into the induction lines round two parallel coils of wire. In the primary coil an intermittent current of electricity from a Leclanché battery flowed; and in the secondary a telephone was connected up to detect the induction sounds. With this apparatus he found that with the coils kept parallel to each other, there were lines, or rather a surface of minimum induction surrounding the primary, and that if the secondary were placed in these lines hardly any induction noise could be detected. A diagram representing a medial section through the coils showed the lines to proceed from the wire of the coils in two curves resembling parabolas—one from each cross-section of the wire outwards.—Dr. Shettle then described his experiments proving the lines of force in a bar-magnet to run spirally round the bar between the equator and poles, the equator being decentred and obliqne across the bar, as shown by diagrams.—Prof. Rowland, of Baltimore, made some observations on the new theory of terrestrial magnetism of Professors Ayrton and Perry. He said the experiments on which the theory was founded had been attributed to Helmholtz, but they were entirely his own, he having gone to Berlin to make them. The new theory had occurred to himself on making these experiments, but he had rejected it because he found that the potential which the earth's surface would require to have would not only cause violent planetary disturbances, but, by mutual repulsion, drive objects off the earth. He had made also an experiment to see if absolute motion of electricity would cause magnetisation, but failed to get any effect from it. Then he resorted to calculation to find the magnetic effect of relative motion by rotation of a charged sphere of perfect magnetic permeability that is more magnetic than iron. He found that when the sphere was uniformly charged and rotating there would be a magnetic field in its interior; but instead of the result of Messrs. Ayrton and Perry, that if the earth were charged to a potential of, he believed, 10^8 volts relatively to interplanetary space, the earth's magnetism would be what it is, he found the necessary charge to be 61×10^{15} volts. In the ordinary atmosphere this potential would produce a spark nine million miles long and discharge across to the moon. If the moon were electrified to the same degree the mutual repulsion would overcome the force of gravity between them. He therefore considered terrestrial magnetism to be still a mystery. He had also thought that the aurora borealis might be explained by supposing the upper regions of the earth's atmosphere electrified. The winds carrying the upper strata towards the poles, electricity would condense there. This hypothesis was still tenable. Prof. Ayrton said that whether or not the new theory of magnetism should be so rejected depended on whether or not Prof. Rowland's calculations, or those of himself and Prof. Perry were wrong. It had been found by Sir William Thomson, from experiments at Arran, that the earth was electrified with respect to the air, and that there is a difference of potential of 30 volts between earth and air for each foot of ascent. This gave 1360×10^{12} centimetre-gramme-second electrostatic units as the potential of the earth. The new theory required the potential to be 1011×10^{11}, supposing the earth to be of solid iron, or about fourteen times more—a wide margin. Prof. Rowland said he had not seen the calculations of Professors Ayrton and Perry yet, but he believed his results to be correct, as he had checked them in various ways.—Mr. Bailley exhibited a modification of Arago's experiment, in which a copper disk is caused to rotate continuously by changing the polarity of four electro-magnets underneath by a revolving commutator.—Mr. Conrad Cooke exhibited a single voltaic element showing the internal current. This is done by forming the glass vessel containing the element into a helical tube between the poles, and hanging a galvanometer needle in the interior of the helix; the internal current deflects the needle.

Geological Society, June 25.—Prof. P. Martin Duncan, F.R.S., vice-president, in the chair.—Edward Garlick was elected a Fellow of the Society.—The following communications were read:—On the evidence that certain species of *Ichthyosaurus* were viviparous, by Prof. H. G. Seeley, F.R.S., F.G.S.—On *Rhamphocephalus prestwichi*, Seeley, an Ornithosaurian from the Stonesfield Slate of Kineton, by Prof. H. G. Seeley, F.R.S.—A contribution to South American geology, by George Attwood, F.G.S. The paper describes a line of country in Spanish Guayana, Venezuela, S.A., commencing from a small town called "the Port of Las Tablas," on the Orinoco River, extending about 150 miles, and consisting of a series of crystalline and altered rocks. Syenite is the first rock met with, and then are found granite, quartz-diorite, hæmatite, and magnetic iron ores, gneiss, slaty rocks, gabbro, and diabase. In the diabase the quartz veins are found to contain large quantities of gold mixed with the vein matter; the alluvial soil in the neighbourhood of the quartz veins also contains gold nuggets and small grains of gold. Although quartz veins are found in great numbers from the river to the interior, none of them have so far

been found to contain gold in any appreciable quantity until the diabase is met with. All the rocks analysed show a higher percentage of silica than is generally found in other localities. Three analyses made from one piece of diabase showing two distinct lines of alteration by weathering (on the original rock), prove that silica is readily dissolved under atmospheric influences, whilst alumina is not. Iron oxides contain more oxygen near the surface than below it. Lime and magnesia are both readily soluble, but lime much more so than magnesia. Soda is more sensitive to weathering than potash. The rocks contain *more combined as well as uncombined* water on their surface than when sheltered from atmospheric influences. The paper was accompanied by an appendix on the microscopical structure of some of the varieties of rocks by Prof. Bonney.—On the so-called Midford Sands, by James Buckman, F.L.S.—On the physical geography of the north-east of England in permian and triassic times, by E. Wilson, F.G.S. In this paper the author seeks to utilise the information he has acquired from the study of the permian and triassic rocks of the above district, towards solving some of the difficult and much debated questions as to their origin. One of the main objects of the paper is to establish the pre-permian origin of the Pennine Chain.—The formation of rock-basins, by J. D. Kendall, C.E., F.G.S.—On the diorites of the Warwickshire coal-field, by S. Allport, F.G.S.—On *Lepidodiscus lebouri*, a new species of *Agelacrinites*, from the carboniferous series of Northumberland, by W. Percy Sladen, F.G.S., F.L.S.—On the ancient river-deposit of the Amazon, by C. Barrington Brown, A.R.S.M., F.G.S. The author described a series of alluvial deposits, varying in thickness from 10 to 160 feet, which have been cut through by the river, and form a series of cliffs, giving rise to striking and characteristic scenery. The succession of beds exposed in these cliffs was illustrated by a number of sections, and it was shown that the strata in question must have been deposited by river action. It was then pointed out that the river is performing two classes of work, namely, cutting away the older sheets of alluvial matter, and depositing the materials derived from them at a much lower level. The interesting phenomena of the cutting of curves by the river, and the abandonment by the river of parts of these curves, giving rise to the formation of lakes, was fully explained; and in conclusion the author showed by a map what vast areas in South America have thus been covered by these alluvial deposits.—The glacial deposits of Cromer, by Clement Reid, F.G.S.—On a disturbance of the chalk at Trowse, near Norwich, by Horace R. Woodward, F.G.S.—The submerged forest of Barnstaple Bay, by Townshend M. Hall, F.G.S.—On a section of boulder clay and gravels at Ballygalley Head, and an inquiry as to the proper classification of the Irish drift, by T. Mellard Reade, C.E., F.G.S.—On the augitic rocks of the Canary Islands, by Prof. Salvador Calderon. Communicated by the President. As the result of a long investigation of the eruptive rocks of the Canaries, and especially of Las Palmas, the author has come to the conclusion that there are two groups of such rocks in those islands, an older one, characterised by the presence of hornblende, and a newer, containing augite. In the latter he finds the essential minerals to be plagioclase, augite, magnetite, olivine, sanidine, and nepheline; and he distinguishes among them the following kinds of rocks, all of which have their characteristic minerals imbedded in a paste of augite and plagioclase:—(1) *Augite-andesite*, with a small quantity of sanidine; (2) *Tephrine*, with no sanidine, but abundance of nepheline; (3) *Basanite*, with some peridote; (4) *Nepheline-basalt*, with abundance of peridote; (5) *Dolerite*, crystalline, characterised by the disappearance of nepheline, the abundance of peridote and porphyritically imbedded plagioclase, and with porphyritically imbedded individuals of augite and olivine; (6) *Felspathic basalt* (like 5), but semicrystalline; and (7) Essentially olivinic modern lavas.—On the Cambrian (Sedgw.) and Silurian beds of the Dee valley, as compared with those of the Lake-district, by J. E. Marr, B.A., F.G.S.—On some superficial deposits in the neighbourhood of Evesham, by the Rev. A. H. Winnington Ingram, M.A., F.G.S.—Descriptions of palæozoic corals from Northern Queensland, with observations on the genus *Stenopora*, by Prof. H. A. Nicholson, M.D., D.Sc., F.G.S., and R. Etheridge, jun., F.G.S. The corals described in this paper were in part collected by the late Mr. Daintree, chiefly from the limestone of the Broken River, regarded as of Devonian age, and in part by Mr. R. L. Jack, from various sources, namely, the Bowen River coal-field, in beds probably of permo-carboniferous age, the Fanning River limestone (Devonian), and the Arthur's Creek limestone (permo-carboniferous). Mr. Daintree's collection also contained corals in the chloritic rock of the Gympsie gold-field. From the Coral Creek, Bowen River coal-field, the authors record *Stenopora ovata*, Lonsd., and *S. jackii*, sp. n.; from the Fanning River limestone, *Heliolites porosus*, Goldf., and *Pachypora meridionalis*, sp. n.; from the Gympsie chloritic rock, *Stenopora?* sp. ind.; from the Broken River limestone, *Favosites gothlandicus*, vars. Lam., *Heliolites porosus*, Goldf., *H. plasmoporoides*, sp. n., *H. Daintreei*, sp. n., *Heliolites*, sp. ind., and *Aræopora australis*, sp. n.; from the Arthur's Creek limestone, Burdekin Down, *Alveolites* (*Pachypora?*), sp., near *A. robustus*, Rom., *Alveolites*, sp. (lobate form), *Aulopora repens*, M.-Edw. and H., *Heliolites porosus*, Goldf., and vars., *Lithostrotion*, sp. ind., *Pachypora meridionalis*, *Trachypora*, sp. ind., and species of *Cannopora* and *Stromatopora*. The genus *Aræopora* is proposed as a new group; the genus *Stenopora* is made the subject of a long discussion; and the geological characters of the deposits from which the fossils are derived are indicated and discussed.

Meteorological Society, June 18.—Mr. C. Greaves, F.G.S., president, in the chair.—Lieut. A. Carpenter, H. Dodd, Capt. D. Galton, F.R.S., S. B. Goslin, A. Gray, Capt. Marshall Hall, W. L. MacGregor, and Rev. W. P. Robinson, D.D., were elected Fellows of the Society.—The following papers were read:—Report on the International Meteorological Congress held at Rome, April, 1879, by Robert H. Scott, F.R.S.—Thermometer exposure: Wall *versus* Stevenson screens, by William Marriott, F.M.S. It being the practice of some observers to expose their thermometers on walls facing north, it seemed a suitable object of inquiry whether instruments so placed gave results comparable with those obtained from thermometers in a Stevenson stand in the open. A pair of meteorological office wall screens were fixed to the brick wall of an outhouse with a northern aspect, so that the screens were in the shade, except in the morning and afternoon of the summer months. The Stevenson screen was on a grass plot 17 feet square, and about 50 feet north of the wall screen. The paper contains the results of the comparison of the maximum and minimum temperatures in the wall screen with those in the Stevenson screen for the twelve months ending March 31, 1879. The figures show that the mean daily maximum temperature on the wall is below that in the open, the monthly differences varying from 0°·0 to − 2°·1, that for the twelve months being − 1°·0. The minimum temperature on the wall was mostly higher than in the Stevenson stand, the differences varying from − 0°·1 to + 1°·3, the mean for the year being + 0°·5. The individual differences, however, are sometimes much greater, the maximum temperature on the wall being considerably lower than that in the stand. For instance, the difference exceeded 4°·0 five times in September, and four times in March, the greatest being 6°·7; these extremes occurred on fine calm days. The minimum temperature on the wall was more than 2°·0 higher than that in the Stevenson stand on five occasions in June, seven in July, and four in September. The mean daily range of temperature on the wall for the twelve months was 1°·4 less than in the stand in the open. The greatest difference was on March 9, when the range on the wall was 8°·5 less than in the stand. These results seem to show that, although the mean temperature may be roughly ascertained from thermometers shaded by a wall with a northern aspect, this method of exposure affords less sensitive indications than those obtained from instruments in a properly exposed Stevenson stand.—On the Hurricane at Mauritius, on March 20th—21st, 1879, by C. Meldrum, LL.D., F.R.S.—On a remarkable disturbance of Barometric Pressure, observed at the Royal Observatory, Greenwich, on May 18th, 1878, by W. Ellis, F.R.A.S.—Meteorology of Mozufferpore, Tirhoot, 1878, by C. N. Pearson, F.M.S.—Meteorological Observations made on the Peak of Teneriffe, by Dr. W. Marcet, F.R.S.—On the temperature of the Atlantic during December, 1877 and 1878, by Capt. H. Toynbee, F.R.A.S.

Entomological Society, July 2.—Sir Jno. Lubbock, Bart., V.P.R.S., president, in the chair.—Mr. Vincent Robert Perkins, of South Belgravia, was elected as an Ordinary Member.—Mr. S. Stevens exhibited living specimens of *Tillus unifasciatus* taken at Norwood.—Mr. McLachlan contributed some further remarks respecting the sculptured pebbles from Lac Léman referred to at the last meeting of the Society.—A number of the perfect insects forwarded by Prof. Forel proved to be *Tinodes lurida*, Curt., a common insect generally on the margins of

lakes and rivers.—Mr. W. L. Distant exhibited a specimen of *Papilio hystaspes*, Feld., taken at sea during a calm thirty miles from Singapore and nine miles from the nearest land.—Mr. W. Cole exhibited a remarkable variety of *Pyrameis cardui*, Linn., taken in Essex.—The Secretary exhibited, on the part of Lord Walsingham, some specimens of a remarkable species of *Tipulidæ* (*Bittacomorpha clavipes*, Fab.) possessing greatly enlarged tarsal joints, captured at Pitt River, California.—Sir Sydney Saunders communicated some additional explanations received from M. Jules Lichtenstein respecting the rearing of the blister beetle, *Cantharis versicatoria*.

Statistical Society, June 30.—Anniversary meeting.—Mr. G. J. Shaw-Lefevre, M.P., in the chair.—The report of the council, the financial statements of the treasurer, and the report of the auditors having been read, the chairman, in moving the adoption of the documents referred to, observed that the Fellows of the Society now numbered 746, and that the increase during the past year over the previous years, and as compared with the average of the last decade (509), indicated the steady progress of the Society. This was confirmed again by the increasing receipts from the sale of the Society's *Journal*. He congratulated the meeting on the satisfactory progress of the Society, financially and otherwise, during the past year. Thomas Brassey, M.P., was elected president. The chairman announced the subject selected for the essays in competition for the Howard Medal of 1880 (with 20*l*.), to be "The Oriental Plague, in its Social, Economical, Political, and International Relations; Special Reference being made to the Labours of Howard on the Subject."

Rome

R. Accademia dei Lincei, June 1.—Prof. Blaserna and MM. Casorati and Brioschi read a report on a memoir by M. Ascoli, on the representability of a function of two variants by double trigonometrical series.—Prof. Blaserna and MM. Felici and Betti read a report on a memoir by Prof. Galileo Ferraris on theorems on the distribution of constant electric currents.—Prof. Blaserna presented a memoir by M. Keller on the secular variation of the magnetic declination at Rome.—The following papers were read:—Contributions to etiology, by M. C. Emery.—Locomotion in the air, by M. Cordenous.—The application of photography to topographical operations, by M. Chizzoni.—President Sella spoke on a paper by M. Valle, a crystallographic study of some bodies of the aromatic series, prepared by Prof. Körner.—M. Lanciani made some demonstrations on malaria and on the subterranean roads in Rome and the Roman Campagna.—On the nature of the specific agent which produces fevers by malaria, by Profs. Tommaso-Crudelis and Klebs.—On the thermic and galvanometric laws of electric sparks produced by complete and incomplete discharges of condensers, by Prof. Villari.

Paris

Academy of Sciences, July 7.—M. Daubrée in the chair.—The following papers were read:—Identity of *Bacillus amylobacter* and the butyric vibrion of M. Pasteur, by M. van Tieghem. The amylobacter, at a certain phase of development, produces a transitory reserve of starch, impregnating its protoplasm. That this occurs in solutions of dextrine or sugar, seems to have escaped the notice of M. Prazmowski and M. Pasteur.—On a new polygraph, an inscribing apparatus applicable to physiological and clinical researches, by M. Marey. He describes modifications by which his apparatus is rendered more portable, simple, and faithful in its indications. In his tambours, the elastic membrane is caught between two annular plates of metal; for transmission of sphygmograph movements he uses caoutchouc tubes rendered inextensible, &c.—On the origin of the excito-sudoral nerve-fibres of the face, by MM. Vulpian and Raymond. The cervical cord of the sympathetic probably contains few, if any, excito-sudoral fibres. The fibres in question come either from sympathetic nerve-fibres accompanying the vertebral artery in its ascending course through the transverse apophyses of the cervical vertebræ and (through these fibres) from the upper thoracic ganglion, or from the parts of the sympathetic coming from the rachidian bulb and the protuberance.—On the inundation of the town of Szegedin, in Hungary, by General Morin. A scientific account of the disaster. From data supplied by Prof. Krusper, of Buda-Pesth, it is shown that in less than fifty years, both as the natural effect of alluvia and that of embankment, the level of flood of the Tisza had risen two metres. General Morin points out the advantage of transferring the clayey and muddy deposits of the river from the lower to the upper parts of the valley, so turning marshes into cultivable land, and increasing the slope of the valley. With this view the dykes of the left bank might be gradually suppressed and replaced by submersible oblique dykes, furnishing successive basins for interception of material.—On the mean value of coefficients in the development of a skew or symmetrical determinant of an order infinitely great, and on doubly skew determinants, by Prof. Sylvester.—Application of sulphocarbonate of potassium to phylloxerised vines, by M. Mouillefert. He gives in a table particulars of the treatments effected by the General Society in the spring of this year. The sulphocarbonate is almost universally applicable for French vineyards, and can be used in any weather or any season without danger to the vine.—On the hypergeometric series and the polynomes of Jacobi, by M. Appell.—On the recent eruption of Etna, by M. Fouqué. The new eruption has produced, on the south-south-west, a fissure having only a few small crateriform apertures, and mouths of emission of lava slightly developed; but on the north-north-east side there are ten distinct craters, two of which are enormous (200 m. diameter, and 80 m. depth).—On the same subject, by M. de Saussure. He describes the phenomena in detail.—Evaporation of water under the influence of solar radiation through coloured glasses, by M. Baudrimont. Green and red, in general, favour the evaporation least, while yellow and red favour it most. M. Baudrimont considers there is probably a simple relation between the number and extent of the luminous waves and the number and extent of those which produce heat, in virtue of which they can be simultaneously propagated through a coloured glass and concur in the effect produced.—Thermo-chemical study of alkaline sulphides, by M. Sabatier.—On a new metal discovered by M. Tellef Dahll, by M. Hiortdahl. He has found it in a mineral composed of arseniuret of nickel (*kupfernickel*) and nickel glance at Oterö, a small island near the town of Krages. He calls it *Norvegium*. It is white, somewhat malleable, and hard like copper ($Ng = 145{\cdot}95$).—On commercial trimethylamine, by MM. Duvillier and Buisine. It is not a simple product, as M. Vincent asserts; of trimethylamine there is only 5 to 10 per cent. in it. Dimethylamine dominates, being about 50 per cent. There are also monomethylamine, monopropylamine, and monoisobutylamine, in nearly equal quantities.—The charbon of ordinary onion (*Allium cepa*), a new disease, originating in America, and caused by an Ustilaginea (*Urocystis cepulæ*, Farlow), by M. Cornu.—Contribution to the physiology of local sweats; local action and antagonism of hypodermic injections of pilocarpine and atropine, by M. Straus.

CONTENTS

THURSDAY, JULY 24, 1879

ROMAN ANTIQUITIES

Roman Antiquities at Lydney Park, Gloucestershire. Being a Posthumous Work of the Rev. William Hiley Bathurst, M.A., with Notes by C. W. King, M.A., Fellow of Trinity College, Cambridge. Pp. vii., 127; Plates xxxi., quarto. (London: Longmans, Green, and Co., 1879.)

LYDNEY PARK appears to be the property of the Bathursts, having been purchased by Mr. Benjamin Bathurst in 1723, so the remains found there have been mostly disinterred under the superintendence of different members of the family in successive generations, and then carefully drawn and described by them. "When the Roman constructions in Lydney Park," the editor tells us in the preface, "were first regularly explored, at the beginning of this century, the Right Hon. C. Bathurst, after taking accurate plans and drawings of the several rooms as they successively came to light, composed a detailed description, in two parts, of the Villa and the Temple." The whole appears to have been found too long and too discursive for publication; so the late Mr. Bathurst, whose name appears on the title-page, "prepared, with great care not to omit any really important particulars, a summary of both these manuscript memoirs; and this forms the text of the volume now printed." But in addition to the papers left by the elder Bathurst, "his daughter, Miss Charlotte Bathurst, had drawn up a descriptive catalogue of coins, selected for their special interest or beauty of condition from amongst the immense quantity found in the course of the excavations." This list Mr. King found "upon examination to exhibit such accurate knowledge of numismatics, coupled with such intelligence in the selection of the pieces," that he has published it without any important alteration; and so far as one can learn from the present volume the Bathursts deserve great credit for this enlightened appreciation of the archæological treasure which had fallen to their lot. But the reader must not be left to conclude that the whole of it has passed through their hands, for Mr. Bathurst says that "Major Rooke, who published some account of this camp in the 'Archæologia,' v. 207, in 1777, was frequently at Lydney, and was allowed to dig wherever he was inclined. Others also were in the habit of searching for coins and other antiquities, and taking them away." Then there has been the usual quarrying for building-stone with the usual result of materially damaging the old pavements, which seem to have still further suffered from a search for iron ore in the limestone of which the hill is composed, on which the camp stood.

So much by way of introduction: I shall not attempt to describe the coins, the articles of bronze or iron, and the tesselated pavements, but confine my remarks to the antiquities relating to the god Nodens, which Mr. King rightly considers to exceed largely in curiosity and value anything of the kind yet discovered in this country. The inscriptions on the votive tablets have long been known, and will be found in the seventh volume of the "Corpus Inscriptionum Latinarum," edited by Hübner for the Berlin Academy. One of them consists of a sheet of lead "carelessly scratched with a graver," and reads in plate xx:—

DEVO
NODENTI SILVLANVS
ANILVM PERDEDIT
DEMEDIAM PARTEM
DONAVIT NODENTI
INTER QVIBVS NOMEN
SENICIANI NOLLIS
PETMITTAS (*sic*) SANITA
TEM DONEC PERFERA[T]
VSQVE TEMPLVM NO
DENTIS.

It is thus rendered by Mr. King: "To the god Nodens. Silvianus has lost a Ring: he has made offering (*vowed*) half (*its value*) to Nodens. Amongst all who bear the name of Senecianus, refuse thou to grant health to exist, until he bring back the Ring to the Temple of Nodens." But why *Silulanus* should be made into *Silvianus* I fail to see; for my part I should regard the former as re-echoing the national name of the Silurians; but that is, of course, another matter.

Another of the tablets is of bronze with *pointillé* letters surmounted with the figure of an animal which the editor pronounces to be a wolf and not a dog as had hitherto been supposed; he believes the vow to have been made on the occasion of an escape from a wolf—it reads thus:—

PECTILLVS
VOTVM QVOD
PROMISSIT
DEO NVDENTE
M. DEDIT.

The chief question which this suggests is what the *M* stands for; Hübner suggests *Marti*, *Maximo*, and *Meritò*, but prefers the two former and gives the first place to *Marti;* but Mr. King does not take this last into account, while he decides in favour of Maximo as against Meritò, and on the whole this seems satisfactory and suits the remaining bronze tablet, which reads in letters, formed in the same *pointillé* fashion as those of the previous one, as follows:—

D. M. NODONTI
FL. BLANDINVS
ARMATVRA
V. S. L. M.

Besides these tablets there have been found at Lydney a number of detached letters cut out of a thin plate of bronze for affixing to a surface by means of small nails in order to make an inscription, as in the case of the *Maison Carrée* at Nismes, excepting that the Lydney ones were, as Mr. King thinks, to be fixed to a wooden surface, probably that of the coffer; but what is interesting is that when sorted the letters make NODENTI SACRVM, excepting that one-half of the letter *s* has not yet been found.

But the inscription which presents most difficulty has still to be mentioned: it is worked into the tesselated pavement of the temple and consists of two long lines. "With the aid of the accurate drawing made at the time of its discovery," and by comparing "the imperfect characters with those well preserved," the editor thinks he has improved on previous attempts to decipher the dedication, which he reads as follows, with the abbreviations extended:—D*eo* M*aximo* IT*erum* FLAVIVS

SENILIS PR*aeses* REL*igionis* EX STIPIBVS POSSVIT O*pitu*LANTE VICTORINO INTER*prete* L*a*TINE. Accordingly he translates:—"To the greatest God, for the second time, Flavius Senilis, Head of the Religion, has erected this, from voluntary contributions, the Director of the works being Victorinus, interpreter for the Latin tongue." On the whole the profession of Victorinus is open to some doubt, as several of the letters following INTER are very far gone; however Mr. King strongly maintains that the hitherto accepted reading of INTERAMNATE is impossible. Perhaps a difference of opinion may still be allowed to exist as to the profession of Flavius Senilis also; but it is tolerably evident both from this inscription and the others already mentioned which were found in the same building, that it was the temple of the god Nodens. That the *D. M.* with which the dedication begins stand for *Deo Maximo* is in Mr. King's opinion put beyond doubt by the heading of the votive tablet of Flavius Blandinus. Such a prelude he thinks is designed to mark the god's supremacy, while his name is superfluous in his own temple, every visitor being supposed to recognise him as "the supreme deity of Siluria." He then goes on to produce reasons for supposing the rebuilding of the temple to have taken place in the time of Agricola and in consequence of the encouragement he gave the Britons to engage in works of civilisation. But the fact of the re-erection taking place under the eyes of the Romans will prepare the reader to find this Silurian deity represented in the classical fashion. Mr. King thinks that he was meant for a sea or river god, and that fact is, in his opinion, "placed beyond doubt by the design of the pavement, *dedicated to him*, be it observed, that decorates the floor of the temple." The description he gives of them is as follows (p. 39):—"The centre is formed by two sea-serpents, represented in the usual form given by the Greek painters to the dreaded κῆτος, as it is seen in the Pompeian wall-painting of Perseus and Andromeda. This sea-monster closely resembles the ichthyosaurus of geologists, with its elongated neck and pectoral paddles, or 'flippers,' which are coloured bright red in our mosaic to augment the savageness of its aspect. The field is occupied with figures of fish, evidently salmon, the chief glory of the Severn." We have not yet done with the pavement, for in the part occupied by the dedicatory inscription, but not quite in the centre, seemingly not to cut up the names, as Mr. King thinks, there is what he describes as "a circular opening, nine inches in diameter, surrounded by a broad red band, again inclosed in two others of blue. That some high mystery was involved in the setting of this unsightly object in so conspicuous a position cannot admit of any doubt." He comes to the conclusion that this funnel was meant to receive libations poured to the god, and that they were drunk up by the dry soil beneath. He further compares this opening in the pavement "to the well of salt water, that famous memorial of the former presence of Poseidon, in the Acropolis of Athens."

In addition to the foregoing inscriptions there has been found there what is described by the editor as "a bronze plaque, clearly intended for personal decoration; the most obvious purpose to which it can"—he thinks—"be assigned, being that of the frontlet of the head-dress worn either by the idol itself or by the officiating priest, after the manner of the large ornamented disks of thin gold so frequently turned up in Ireland." The following is his description of this ornament:—

"In the centre rises a youthful deity . . . . he is crowned with rays like Phœbus (or more probably 'his bonnet sedge,' like Camus), carries a sceptre, and is borne over the waters in a car drawn by four sea-horses, like the Roman Neptune. On each side floats in the air a winged Genius, clearly typifying the Winds, one holding forth in his right the leaf-shaped fan commonly seen in the hands of Roman ladies; the other Zephyr similarly waves a handkerchief; both grasp in the left hand the end of the shawl or *chlamys*, thrown loosely over each arm. Rude as is the engraving, there is a lightness and freedom in the drawing of these figures much to be admired, and expressing with great truth the airy nature of the beings it attempts to embody. Each end of the composition is filled up with a reclining Triton; the one brandishing two paddles of the very shape still employed by those that navigate the primitive British bark, the coracle; the other, an anchor, and his proper attribute, the shell-trumpet, the *cava buccina*, assigned to him by Ovid."

There remains another piece of ornamentation, which Mr. King regards as a fragment of the foregoing; but I must give his own words:—

"On the smaller fragment, evidently part of the same decoration, Triton is yet more distinctly represented; he is here winding a blast on his conch to call the winds to do him service, whilst he wields the anchor for sceptre; on the other side sits the votary of Nodens, the Silurian fisherman, enveloped in the hooded frieze mantle worn to this day by his brethren of Naples, and who, by the favour of the god, has just hooked a magnificent salmon."

Mr. King is somewhat unlucky when he comes to touch on questions of Celtic philology, as will be seen from the following extract:—

"Dr. McCaul quotes from a letter from Meyrick to Lysons that 'Deus Nodens seems to be Romanised British, which correctly written in the original language would be Deus Noddyns, the "God of the abyss," or it may be "God the preserver," from the verb *noddi*, to preserve; both words being derived from *nawdd*, which signifies protection.' Prof. Jarrett, a profound Celtic scholar, to whom I applied for a translation of 'Deus Noddyns' without mentioning Meyrick's explanation, at once rendered it as 'God of the deeps,' a sense that every circumstance confirms."

What Meyrick may have said to Lysons on Celtic philology had best be forgotten, and with all respect to a Celtic scholar with whose name I do not happen to be acquainted, it will be at once admitted by all those who know Welsh, that *Noddyns* is gibberish; nay, I might go so far as to say that it could not be made to fit into the vocabulary of any Celtic language past or present. The word which in all probability suggested it to Meyrick was *anoddyn* or *anoddyfn*, "abyss," with which *Nodens*, however, could not, according to any known rules of Welsh phonology, be connected. This wretched bit of philology does not, I am glad to say, vitiate the rest of the editor's reasoning, which seems to me so good that I should like to put him on another tack. In a lecture not yet published, but delivered before the present volume was published, I ventured to equate the name of the god with that of another, which I thought I detected in an Irish proper name: I allude to Mogh Nuadhad (in an older orthography Mog Nuadat), the name of a Munster prince

well known in Irish legend. It means the slave or servant of Nuadha, and belongs to a group of Irish proper names which I take to be of a Non-Aryan origin, and to mark the præ-Celtic race of Ireland. Another of the same kind was Mogh Néid, the slave or servant of Néid; for the Ancient Irish had a god of war called Néid or Nét.

This kind of nomenclature, I need hardly say, is well known on Semitic ground: take, for instance, the biblical *Abdiel*, "servant of God," or the inscriptional *Abdastartus*, "servant of Astarte." On the other hand the Aryans gave the preference to compounds such as the Sanskrit Deva-datta, Greek Θεό-δοτος, or the Welsh *Cad-wal*, Irish *Cath-al*, Old German Hatho-wulf, or the wolf of war. To return to Lydney, the name *Nodens*, genitive *Nodentis* is precisely what would make in Irish, according to the phonological laws of that language, a nominative *Nuadha*, genitive *Nuadhat*, that is on the supposition that the first syllable of the god's name was long, *Nōdens* or *Nūdens;* further, corresponding to an Irish nominative *Nuadha*, the Welsh form should be *Nudd*, with *ū* pronounced nearly like German *ü*, and *dd* like *th* in the English word *this;* and Nudd occurs in Welsh both in prose and verse, namely, in connection with *Edern son of Nudd* and *Gwyn son of Nudd*, where it probably meant a god-ancestor rather than the father; compare Bran son of Llyr, that is, Bran son of the Sea. Even the hesitation in spelling between *Nodens* and *Nudens* fits exactly into Welsh phonology, which makes both the ō and the ū of the language in its early period into ū in its later stages; from the Lydney inscriptions this would seem to have been nearly accomplished in the first century.

It is unfortunate that Welsh literature gives us no information as to the attributes of Nudd; the case is much the same with Nuadha in Irish literature, but it is right to say that the latter makes Nuadha to be a king of the Tuatha Dé Danann, that is to say, king of the most mythical race in Irish legend, and the following passage in O'Curry's Lectures on the Manners and Customs of the Ancient Irish (iii. 156) is to the point, though he gives no reference to the original, which he had in view in it:—"The river Boyne, from the clearness of its waters, was poetically called *Righ Mná Nuadhat;* that is, the wrist or forearm of *Nuadhat's* wife. This lady was one of the *Tuatha Dé Danann;* and the poetical allusion to her arm originated from her keeping it constantly covered with rings or bracelets of gold to bestow upon poets and musicians." I am inclined to think that the term *Righ Mná Nuadhat* had a much deeper meaning, and that it is, in fact, a relic of Irish mythology. For there is good ground for believing that the Boyne was personified and probably worshipped; I conclude this from the meaning of its name, which was in Old Irish *Bóind*, genitive *Bóindeo*, and in Ptolemy's Geography Βουουίνδα, *i.e.*, *Buwinda*, which has been equated and, no doubt, correctly with the Sanskrit adjective *govinda*, which, according to the Petersburg Dictionary, means "acquiring or winning cows or herds," and occurs as an epithet to Brhaspati, Krsh*n*a, and Vishnu. In Cormac's Glossary we learn that the Boyne had another name, Bergna or Bregna, which also appears to have been personal. In Britain, the Dee, for example, was undoubtedly regarded as a divine stream, and probably also Ptolemy's Belisama wrongly identified in my Lectures on Welsh Philology with the Dee. If, then, the Boyne was such another river divinity, nothing could be more natural than for the muse of mythology, if I may use the term, to marry her to Nodens, god of the sea, if it is right, as it seems to be, to describe him as such.

Mr. King touches on several minor points of great interest to Celtic philologists, as, for instance, when he says of Senilis, "that his uncommon *cognomen* is probably a translation of his British name, *Hen*, the Old;" but it is hardly necessary to speak here of a translation, as at the date of the dedication *hen* was *sen* in all Celtic languages, and the Welsh change of initial *s* into *h* did not set in for centuries afterwards. With *Senilis* may be compared or contrasted the Senilus of the post-Roman inscription of St. Just in Cornwall, see p. 406 of the Lectures on Welsh Philology, and also the "Grammatica Celtica," p. 769, where an Irish name is mentioned as written *Sinill*, with which may be compared the *Senyllt* of later Welsh: more than one of these forms seem to postulate a Latin Senilius. Hübner has other instances of *Senilis* besides the one from Lydney. Quite distinct from the fortune of initial *s* was that of vowel-flanked *s*, as it has disappeared without a trace both in Welsh and Irish, and that probably at a very early date: possibly before they had differentiated themselves into distinct languages. The Lydney inscriptions seem to me to give strong indirect evidence to the effect that it had in this country disappeared before the first century; for the best explanation of the doubling of the *s* in POSSVIT and PROMISSIT is to suppose the inscriber to have been a Celt, in whose language, as in Welsh and Irish, a soft *s* or single *s* between vowels was unknown; his mistake could be copiously paralleled by the way Welshmen of the present day deal with English *s* and *z*. I suspect also that the Celtic word for god, of the same origin and derivation as the Latin *divus* and beginning, as it must have in early Welsh, with the syllable *dēv*, had not a little to do with the spelling DEVO in the tablet of Silulanus.

I cannot end this somewhat lengthy notice without heartily thanking Mr. King and the Bathursts for a volume so full of interest and so well got up.

JOHN RHŶS

THE RIGHTS OF AN ANIMAL

The Rights of an Animal; a New Essay in Ethics. By Edward Byron Nicholson, M.A., Principal Librarian and Superintendent of the London Institution. (London: C. Kegan Paul and Co., 1879.)

THIS is a little book—too little to be satisfactory. Its object is to argue that "*animals have the same abstract rights of life and personal liberty with man.*" The ambiguity which attaches to the word "same" in this opening statement of the "principle" to be proved casts its shadow over all the remaining sixty pages of which the essay consists. That animals have not in all respects *identical* "rights of life and liberty with man" is too obvious a truth for even Mr. Nicholson to combat. He neither objects to the slaughtering of animals for food nor to the working of animals for purposes useful to man. Yet if the rights of animals were, strictly speaking, "the same" as those of man, the former act

would be one of murder, and the latter one of unjustifiable slavery. It is clear, therefore, that for the purpose of lucid statement we ought to be supplied with some definition of the sense in which the author supposes the rights of animals to be comparable with those of man. And it is because this definition is nowhere supplied that we deem the work unsatisfactory. That animals, as sentient creatures, have *some* rights—*i.e.*, that man may not kill or torture them needlessly without incurring *some* moral blame—no one nowadays would undertake to dispute.[1] It therefore seems useless to fill a number of pages with a number of truisms on the theme that animals have some rights in common with man. From the writer of "a new essay in ethics" we expected to find a statement of the principles by which the rights of animals ought to be defined—in what they resemble and in what they differ from the rights of man, and why. But instead of this we find only the statement of a fact which it does not require "a new essay in ethics" to reveal, viz., that the immorality of subjecting animals to needless death or torture cannot be justified on the ground of any such irrelevant or untrue arguments as that animals are irrational, not immortal, or non-sentient. Such being the whole scope of the work, it seems to us to be about a century too late in appearing.

At the present time, when the ethics of vivisection and kindred questions are being so warmly discussed, there is a good opportunity for a competent essayist to write an interesting, if not valuable treatise, on the basis, the nature, and the extent of animal rights, as well as the ways and degrees in which these rights ought to be respected by man. The latter subject is lightly touched by Mr. Nicholson in his concluding chapter, entitled "Limitations in Practice." His view appears to be that man has no moral justification in taking the life of any animal, which is not either directly "harmful" to himself or in competition with him in "the struggle for food." Therefore Mr. Nicholson considers it immoral to eat shrimps and lobsters, seeing that they neither "hamper man's comfort nor eat up his food." Criticism here is sufficiently easy. Among animals themselves the only right is might, and therefore if a lobster could argue with a philosopher it is difficult to see on what grounds he could convince the superior animal that the latter has less right to eat him than has his brother lobster. If the lobster were to urge that the philosopher is not merely an animal but a moral animal, the philosopher might answer that he cannot see any moral justification of the lobster's view that the right of an edible animal to live is superior to the right of an eating animal to kill. And if the lobster were unfortunate enough to quote Mr. Nicholson as an authority to prove that man has a moral right to kill only "hurtful" animals, it would be competent for the philosopher to reply that if man has a moral right to promote his own happiness by killing animals which cause him harm or annoyance, it is impossible to see why he should not have a similar right to promote his own happiness by killing all animals that serve him for food.

[1] Dr. Whewell is probably the last of competent writers who has done so in the past or is likely to do so in the future. It is remarkable, by the way, that Mr. Nicholson does not quote the passage in which Dr. Whewell sneers at Bentham for maintaining the rights of animals as sentient creatures, for this passage, especially as answered by Mill, would have gone further to argue the existence of obtuseness upon this subject than does any other fact which is mentioned by Mr. Nicholson.

Lastly, if the lobster were to argue that his enemy might secure a doubly beneficial end by limiting his diet only to such animals as are noxious, the philosopher would be compelled to observe that he happened to prefer lobster salad and roast lamb to boiled snakes and rat-pie.

The same inconsistency of principle is displayed where Mr. Nicholson treats of vivisection. He says "much against my feelings I do see a warrant for vivisection in the case of harmful animals and animals which are man's rivals for food." But if man has a moral right to slay a harmful animal *in order to better his own condition*, he must surely have a similar right to slay a harmless animal, *if by so doing he can secure a similar end.* And of course it is the opinion of all sufficiently informed persons that vivisection has been of more service in bettering the condition of humanity than has the destruction, say, of wolves, bears, and tigers, wherever these animals have been destroyed.

OUR BOOK SHELF

Proceedings of the Aberdeenshire Agricultural Association, 1878.

We have already noticed the earlier field experiments made by this Association. The most prominent fact which they believe they have established is the efficacy of mineral phosphates, when in fine powder, as a manure for turnips. Such phosphates have always been treated with sulphuric acid, and converted into superphosphate before being employed as manure; to employ them in fine powder without this previous treatment would of course be more economical, if they are in this state sufficiently effective.

It would be easy to criticise the experiments on which the above conclusion is based; we might especially point out the very different results which the same manure has yielded on different plots of the same land. The manure has also apparently been incorporated with the soil in a far more perfect manner than would be possible in agricultural practice, and the solvent action of the soil has thus been greatly aided. We must leave therefore any conclusion as to the feasibility of employing finely-powdered apatite or coprolite as a manure until repeated trials have been made on a large scale. There are, however, a few facts in the chemistry of the question to which we should like to call attention.

If we were asked to describe a soil which should exercise the greatest solvent action on phosphate of calcium, we should certainly name one containing much humic matter, and little or no carbonate of calcium. The humic matter, and the carbonic acid produced from it, would act as a tolerably powerful solvent for the phosphate, if carbonate of calcium were not present to neutralise their efficacy. Now the granite soils of Aberdeen belong precisely to the class of soil just described; if, therefore, it should be finally proved that finely-powdered mineral phosphates are almost as effective as superphosphate on land of this character, it will by no means follow that the same result will be obtained if the phosphate is applied to other soils, and especially to those derived from limestone rocks.

As to the effect of nitrogenous manures on the turnip crop, the conclusion first arrived at by the Association has been somewhat modified. In the previous report it was stated that the only effect of nitrogenous manure was to increase the amount of water in the crop; this extraordinary conclusion has not been confirmed by the succeeding experiments. As the turnip crop contains a large amount of nitrogen as a necessary constituent, it is clearly ridiculous to speak of nitrogenous manures as

only capable of increasing the proportion of water in the crop; if nitrogenous manures are found in any case to be of little value, it is not because the plant does not require nitrogen, but simply because the soil supplies an abundance without the aid of manure. Concerning the richness of the experimental soils in nitrogen nothing is said. Mr. Jamieson, the chemist of the Association, has, however, stated in another publication that the Aberdeenshire soils usually contain 0·4 per cent. of nitrogen. If this is the case, there is little reason to wonder at the small effect of nitrogenous manures. The amount of nitrogen just named is far in excess of that usually found in arable soils, and about equal to what we should expect to find in the soil of a well-manured kitchen garden.

The percentage of water in a plant is always increased by anything which increases its luxuriance: a big turnip is sure to contain a greater proportion of water than a little one. If, therefore, we are to condemn manures simply because they increase the percentage of water, we may as well stop manuring altogether. It is quite right, however, that the percentage of water in the produce should be taken into account in comparing the effect of different manures, as it is clear that only the dry matter of the crop can have any feeding value.

The experiments, as before, exhibit a vast amount of painstaking work, and cannot fail, if continued in the same spirit, to be of service to the farmers of Aberdeen.

A History of British Freshwater Fishes. By the Rev. W. Houghton, M.A., F.L.S., Rector of Preston-on-the-Weald Moors, Wellington, Shropshire. Two volumes, extra large 4to. (Copies to be obtained from the author at the above address.)

THE most complete monograph on this branch of natural history which has yet appeared, several species of *Salmonidæ* being illustrated for the first time. The coloured figures and the engraved lake and river scenes, which head each chapter, are admirable works of art. The book is exquisitely got up, and is well suited to the drawing-room table. At the same time, it is of real scientific value to the amateur ichthyologist, the descriptions and plates rendering the species of easy identification. The preliminary chapters on the classification and anatomy of fishes are carefully written and well illustrated. The work will add to Mr. Houghton's reputation as an intelligent and accomplished naturalist. C. C.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Price of the "Memoirs of the Geological Survey"

THE publication of Mr. Skertchley's "Manufacture of Gun Flints," in the Memoirs of the Geological Survey, seems to be a good opportunity for again bringing under notice the absurd price charged for some of the Survey volumes. In NATURE, vol. xviii. p. 562, Prof. Boyd Dawkins drew attention to this subject, and urged the necessity of issuing the "Memoirs" at a reasonable price; but this last publication shows that the Stationery Office does not intend to mend its ways, but will still try and put the information it issues as far as possible out of the reach of the public. The fact I should like to draw attention to as regards the price of the "Memoirs" is the absurdity of the amount charged for some of the volumes, as proved by others issued by the Survey; and a glance at the facts seems to show that the prices are fixed without any regard to the size or quality of the book. Mr. Skertchley's pamphlet consists of 80 pp. and 71 figs., and this, in a paper wrapper, is priced 17*s.* 6*d.*! Now, take Prof. Jadd's "Geology of Rutland," this contains 320 pp. (or exactly four times as many as Mr. Skertchley's) 11 plates and 19 woodcuts, and the price of this, in cloth, is 12*s.* 6*d.*, or 5*s.* less than the one of 80 pp. Another example is Mr. De Rance's Memoir on the "Superficial Geology of the Coasts of South-west Lancashire," which consists of 139 pp., and 20 woodcuts, and for which we have to pay 17*s.*; compare with this Mr. Woodward's "East Somerset and Bristol Coalfield," containing 271 pp., 9 plates, and 23 woodcuts, which is only one shilling more than the last-named, and is issued in cloth. But perhaps the most curious two to take together are Mr. Skertchley's volume on the "Fenland," and Prof. Green's "Report on the Yorkshire Coalfield." The former of these contains 335 pp., 24 plates, and 36 woodcuts, and is published at 2*l.*, the latter has 823 pp., 26 plates, and 125 woodcuts, and yet the price is only 2*l.* 2*s.* It is certainly hard to understand why we should be charged 2*l.* for Mr. Skertchley's volume, if one the size of Prof. Green's can be produced for 2*l.* 2*s.* One would imagine that books issued with the public money would be sold as cheaply as possible; and it is to be hoped that some friend to Science in Parliament will ask a question of the Government, and see if it is absolutely necessary that these Memoirs should be published at such famine prices.

Oxford JAS. B. BAILEY

The Sea-Serpent

IN NATURE, vol. xix. p. 286, I observed some remarks respecting sea-serpents, and especially noted one passage which stated that "The age of incredulity is past, and naturalists are now prepared to admit that several distinct kinds of oceanic monsters probably exist."

I was pleased to read this statement, as I have for many years been convinced that some of the accounts published from time to time in the newspapers are accurate descriptions of what has actually been witnessed, but I little expected that I should so soon be able to forward to you a description of one of these creatures, as given by an eye-witness, of whose accuracy there can be no question, and whose observations were made when very close to the animal.

Busselton is a little seaport about 150 miles south of Fremantle, on the west coast of Australia, situated on the shore of Geographe Bay, which is sheltered by Cape Naturaliste; the northern point of that singular projection on the south-west corner of Australia.

During the greater part of the year the water of Geographe Bay is as smooth as a lake, though it is a portion of that vast Indian Ocean which extends unbrokenly to the African coast. The beach is of smooth white sand, so hard at the water's edge that it is frequently used as a road for riding or driving from Busselton to Lockville; the latter place, a few miles to the north, is the station of the Ballarat Timber Company, containing their steam saw-mills, the termination of their railway, and the jetty from which large quantities of that imperishable and valuable timber called jarrah is exported to be used as piles, railway sleepers, &c.

Last month I heard a report that the sea-serpent had been seen near Busselton, and that the resident clergyman had been one of the spectators. Having the pleasure of personal acquaintance with that gentleman, I wrote to him on the subject, and received from him such an interesting account, that I applied to him for permission to communicate the facts to your paper, and verify them by publishing his name. It is fortunate that the principal eye-witness was an educated gentleman, who has for twenty-seven years been a Colonial chaplain in this colony, and whose description of what he saw is clear, simple, and free from exaggeration.

I copy from the letters of the Rev. H. W. Brown the following extracts:—

"On Sunday, March 30, I left Lockville just as the sun was setting, on my way home by the beach.

"The afternoon had been oppressively hot, not a breath of wind, and the sea was as smooth as a glass. I met C. M'Guire and his wife walking towards Lockville.

"Soon afterwards, when abreast of the track to Richardson's, I noticed ahead of me what looked like a black log of wood in the water a stone's throw from the shore, nearly end-on to me, and apparently more buoyant at that end; getting nearer, I noticed that it was *drifting* apparently towards Lockville, and soon discovered that it was moving, leaving behind it a very long, narrow ridge on the smooth water. I then turned my horse's head, and, at a walking pace, kept just abreast of it, un-

noticed apparently, till I had gained sufficiently on M'Guire to make him hear. I then coo-eed *once;* he turned and came back to meet me; but at the sound of my coo-ee the fish started off seawards out of sight (under water), and doubled again in-shore, but so rapidly as to leave both outward and inward "ridge" on the water distinctly visible at once, like a wide V with quite a sharp corner. It gave me the idea of two fishes, the one darting outwards, the other crossing its track inward at the same moment.

"Not knowing where it might show up next, but satisfied that it had come in-shore again, I tried by pointing seaward to direct M'Guire's attention that way.

"Just as I met him the fish again came to the surface, showing gradually more and more of his length, till, when he was almost at rest, and all apparently was in view, I estimated the length to be 60 feet, straight and taper, like a long spar, with the butt-end, his head and shoulders, showing well above the surface.

"I can only describe the head as like the end of a log, bluff, about two feet diameter; on the back we noticed, showing very distinctly above water, several square-topped fins."

I here make an exact tracing from Mr. Brown's letter of his sketch:—

"It was now getting rather too dark to see details distinctly. The fish proceeded towards Lockville, and I turned homeward. M'Guire said he would go on to Lockville jetty and look out for him there.

"Whether he saw him again I know not, but M'Mullan, the fisherman, told me next morning that he had seen it about fifty yards from that jetty, and it looked to him about twenty feet long. So it did to me while in motion; only when at rest for a moment did its whole length show up sufficiently. What its propelling power was I cannot say from observation; I saw no lateral fins and no fish-tail.

"When it started away at the sound of my voice, it was with the rapid movement of a pike or sword-fish, and yet the thick, bluff head had but little resemblance to a snake's.

"There was an unusual abundance of fish close in-shore the same afternoon, yet when I saw the stranger there were certainly no fish of which it could be in pursuit."

Since the year 1848, when the captain and officers of a British man-of-war gave evidence that they passed within 100 yards of a snake which they estimated to be 60 feet in length above water with probably 40 feet beneath, I do not know of any more clear account than the above. Many independent accounts of the existence of marine monsters have been placed on record, and it seems mere folly to treat these repeated reports with ridicule.

I trust that your readers will no longer doubt that "the age of incredulity" is past.

H. C. BARNETT,
Colonial Surgeon

Fremantle, W. Australia, May 19

Mechanical Difficulty in Growth of Plants and Animals

IN reading reports and discussions on natural science, to which I am, from great pressure of other occupation and studies, only able to give a cursory attention, I cannot find any allusion to the *mechanical* means by which the growth of organised creatures is produced, especially when that growth takes place in opposition to the direction of gravitation. The explanation at which I have arrived of this phenomenon may probably be known to physiologists, and may have been acknowledged or disproved; any way I think the subject might be fairly discussed in a popular journal such as yours.

The growth of the roots of a plant and of drooping branches not being in opposition to the attraction of the earth, presents only the difficulties which arise from vital action, but the increase of a plant in height requires also explanation as to how the work is done of lifting vegetable matter higher and higher; capillary attraction can bring fluid to the summit of a tube such as the stem of a plant, but the fluid cannot overflow at the top, since in that case the matter of the tube would lift the fluid above itself; but when a tube is full of fluid, additional heat expanding this fluid would cause it to overflow at the top of the tube. As the sap contains solids in solution, from this the fluid could deposit an additional length of tubing, in which again an additional length of the column of fluid could be absorbed, so the heat of each day would build up a higher vertical tube, and capillary attraction would account for the cooler fluids produced at night or rising from the root filling the vessels to their extremities. It seems to me, therefore, that the work done in lifting vegetable matter to the apex of a plant is due to the increase of heat in the daytime; that then the watery particles are evaporated, and the solid left deposited in the form of cylindrical vessels of small bore. In animals the prostrate posture of rest allows of growth without the difficulty of resisting gravitation; it is well known that deficiency of sleep (perhaps more accurately of rest) stunts the growth of animals, and that illnesses which keep children in bed during their years of growth almost always cause a rapid increase of stature; surely this arises from the newly-formed tissues having no gravitation to overcome, and therefore developing rapidly. Probably if a child were taught to take rest in a vertical position, it would not grow tall, but develop in breadth.

The work done in increasing the stature of plants every year must be enormous; in one summer thousands of tons of vegetable tissue must be raised through heights varying from a few inches in an oak, to twenty or thirty feet in a hopbine, and much more in a lliano, or tropical creeper. I presume in winter the cold constricts the vessels, and so prevents sap from rising, hence there is no growth at that season.

Taunton College School H. P. KNAPTON

Chemical Notation

IN Mr. Pattison Muir's very interesting article on thermo-chemical investigation (NATURE, vol. xx. p. 8, I find the following:—

"That system of notation which is now employed in chemistry, although of the greatest value, is nevertheless far from being perfect; it fails to tell anything concerning the changes in forms of energy involved in those changes of distribution of mass (matter?) which it formulates."

The author does not, however, propose any addition to the usual notation for the purpose of indicating the transformations of energy which take place in chemical transformations, yet this may be done very simply.

The symbol for water is $HO\frac{1}{2}$. This states with perfect clearness the fact that a molecule of water has been formed by the combination of a molecule of hydrogen with a half molecule of oxygen, but it leaves out of account the important fact that in the act of their combination 34462 heat-units have been given out. If we call a heat-unit θ, the symbol for water will then be $HO\frac{1}{2}—34462\ \theta$; the negative sign indicating that the heat has been *parted with*. I propose to call such compounds thermo-negative. Products of perfect combustion, such as water and carbonic acid, are necessarily thermo-negative.

There are thermo-positive compounds, of which protoxide of nitrogen is one of the best understood. According to Fabre and Silbermann, 1154 heat-units are given out in the separation from protoxide of nitrogen of one gramme of oxygen. It is obvious that this heat must have been *taken up* in the formation of the protoxide. Multiplying 1154 by 8 for the equivalent of oxygen, we get 9232 as the thermal equivalent of the protoxide, and we write its symbol $NO + 9232\ \theta$.

Peroxide of hydrogen is usually written HO, but this, from the point of view of chemical structure, is altogether wrong. Fabre and Silbermann "estimate the heat evolved during the liberation of one gramme of oxygen from peroxide of hydrogen at 1363 heat-units. Multiplying by 8 as before, we have 10904 as its thermal equivalent, regarding it as a thermo-positive oxide of water, and we write its symbol

$$(HO\tfrac{1}{2} - 34462\ \theta) + O\tfrac{1}{2} + 10904\ \theta.$$

JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim, July 8

Local Colour-Variation in Lizards

MR. HENRY HILLYER GIGLIOLI remarks (NATURE, vol. xix. p. 97) that the common lizard (*Podarcis muralis*) constantly presents dark varieties on islets adjoining small islands. A similar case has come under my observation in the herpetological fauna of this country. *Ameiva* (cnemidophorus) *vulgaris*, Licht., is very common all over Venezuela, and though it varies considerably in colour, it is, on the mainland, never black, as on the small islands of Los Roques and Orchila, which lie a short distance off our Caribbean coast. Both islands have rather extensive sandy beaches, covered with a very scanty vegetation, so that, *mutatis mutandis*, they are, in the very words Mr. Giglioli uses when speaking of Filfla, painfully white in the glaring

tropical sun, the black lizards being therefore most conspicuous. Prof. Peters, of Berlin, to whom some years ago I sent specimens of these reptiles, called them in one of his letters *Cnemidophorus nigricolor*, but as I am not aware of his having published this name, I believe he got soon convinced of its true character as a melanotic variety. I may be allowed to add that I have mentioned this case already in my "Estudios sobre la Flora y Fauna de Venezuela" (Caracas, 1877), pp. 280, 281, when I also pointed out the difficulty of its explanation by the "struggle for existence" theory. A. ERNST

Caracas, May 15

Intellect in Brutes

1. THE following case was witnessed by my friend Dr. Rafael Villavicencio, of Caracas, during his stay last year in the town of Ponce, in the Island of Portorico:—

The little river in the neighbourhood of the town had risen, in consequence of heavy rains, and ran with rather considerable swiftness. In a certain place it is crossed by a road, where it was forded by a countryman sitting on his mule cart. His dog swam after him, but was taken down by the current and carried back to the bank. Then, after a moment's hesitation, the animal ran some distance up the bank, jumped into the water, and managed to reach the other side just where the road emerged from the river, acting thus precisely as a boatman might have done in similar circumstances.

2. To my friend Dr. Velasquez Level, a respectable physician of this city, and for several years a resident of the Island of Margarita, I am indebted for the following touching instance of the sagacity of a bitch. Her owner, for some reason or other, had destroyed all the female puppies in two successive litters. On her having brought forth a third one it was found that there were but three male puppies. The bitch, however, was observed to leave her whelps occasionally, and to return some time after. Being followed, she was discovered suckling three female puppies, which she had hidden under some brushwood, undoubtedly with the intention of saving them from the master's cruel hands. This case happened in a small place, called Juan Griego, on the northern side of the island. A. ERNST

Caracas, May 15

Intellect in Brutes—a Cat and a Mirror

MANY years ago at Carne farmhouse, where relatives of mine were then living, the household cat was observed to enter a bedroom in course of being spring-cleaned.

The looking-glass being on the floor the cat on entering was confronted with its own reflection and naturally concluded that he saw before him a real intruder on his domain.

Hostile demonstrations were the result, followed by a rush to the mirror and then meeting an obstacle to his vengeance, a fruitless cut round to the rear. This manœuvre was more than once repeated with of course equal lack of success. Finally the cat was seen to deliberately walk up to the looking-glass keeping its eyes on the image, and then when near enough to the edge, to feel carefully with one paw behind, for the supposed intruder, whilst with its head twisted round to the front it assured itself of the persistence of the reflection.

The result of this experiment fully satisfied the cat that he had been the victim of delusion and never after would he condescend to notice mere reflections, though the trap was more than once laid for him. THOS. B. GROVES

Butterfly Swarms

EVEN your varied correspondence from all parts of the world has rarely furnished us with such a wonderfully complete and interesting personal observation as that of Mr. Sydney B. J. Skertchly (NATURE, vol. xx. p. 266) on the West African breeding-grounds of *Vanessa cardui*, and the almost mechanical impulse and simultaneity with which such a swarm as that which he describes free themselves from the pupa-case and set forth on their migration. Can any one throw a similar light on the periodicity of *Colias edusa?* *V. cardui* is a more constant insect in this neighbourhood than any other with which I am acquainted; but the numbers in June of this year were quite unusual. Also we remarked that they were very high-coloured and vigorous, unlike the ordinary washed-out hybernated specimens of early summer. As one of your correspondents has remarked of his neighbourhood, so here *C. edusa* swarmed in 1877. It was the prevailing insect. In 1878 we had hardly a solitary example. The so-called *C. helice*—the pale variety of *C. edusa*—was frequent in 1877. I saw none of *C. hyale;* indeed, have never seen that insect here. HENRY CECIL

Bregner, Bournemouth

REPORT OF AN UNUSUAL PHENOMENON OBSERVED AT SEA

THE following Report to the Admiralty has been communicated to us for publication by Capt. Evans, C.B., F.R.S., the Hydrographer to the Navy:—

H.M.S. *Vulture*, Bahrein, May 17, 1879

SIR,—I have the honour to inform you that, at about 9.40 P.M. on May 15, when in lat. 26° 26′ N. and long. 53° 11′ E., a clear, unclouded, starlight night, Arcturus being within some 7° of zenith, and Venus about to set; wind north-west, force 3, sea smooth, with slight swell from the same direction; ship on starboard tack, heading west-south-west and going three knots, an unusual phenomenon was seen from the vessel.

I noticed luminous waves or pulsations in the water, moving at great speed and passing under the ship from the south-south-west. On looking towards the east, the appearance was that of a revolving wheel with centre on that bearing, and whose spokes were illuminated, and looking towards the west a similar wheel appeared to be revolving, but in the opposite direction. I then went to the mizen top (fifty feet above water) with the first lieutenant, and saw that the luminous waves or pulsations were really travelling parallel to each other, and that their apparently rotatory motion, as seen from the deck, was caused by their high speed and the greater angular motion of the nearer than the more remote part of the waves. The light of these waves looked homogeneous, and lighter, but not so sparkling, as phosphorescent appearances at sea usually are, and extended from the surface well under water; they lit up the white bottoms of the quarter-boats in passing. I judged them to be twenty-five feet broad, with dark intervals of about seventy-five between each, or 100 from crest to crest, and their period was seventy-four to seventy-five per minute, giving a speed roughly of eighty-four English miles an hour.

From this height of fifty feet, looking with or against their direction, I could only distinguish six or seven waves; but, looking along them as they passed under the ship, the luminosity showed much further.

The phenomenon was beautiful and striking, commencing at about 6h. 3m. Greenwich mean time, and lasting some thirty-five minutes. The direction from which the luminous waves travelled changed from south-south-west by degrees to south-east and to east. During the last five minutes concentric waves appeared to emanate from a spot about 200 yards east, and these meeting the parallel waves from south-east did not cross, but appeared to obliterate each other at the moving point of contact, and approached the ship, inclosing an angle about 90°. Soundings were taken in twenty-nine fathoms; Stiffe's Bank, with fifteen to twenty fathoms, being west about one mile. The barometer was already at 29·25 from 8 to 12 P.M.

	At 8 P.M.	10.15 P.M.	Midnight.
Temperature of air ...	84 ...	83 ...	83
Temperature of sea-water ...	84 ...	82 ...	82

I observed no kind of change in the wind, the swell, or in any part of the heavens, nor were the compasses disturbed. A bucket of water was drawn, but was unfortunately capsized before daylight. The ship passed through oily-looking fish spawn on the evening of the 15th and morning of the 16th inst.—I have the honour to be, Sir, your obedient servant,

J. ELIOT PRINGLE, Commander

GENERAL RESULTS OF EXPERIMENTS ON FRICTION AT HIGH VELOCITIES MADE IN ORDER TO ASCERTAIN THE EFFECT OF BRAKES ON RAILWAY TRAINS

THE experiments were made on the Brighton Railway, with the assistance of Mr. George Westinghouse, with a special four-wheeled van constructed for the purpose; it was attached to an engine, and was run at various speeds, during which time various forces were measured by self-recording dynamometers. The principle of these dynamometers is that the force to be measured acts on a piston fitting in a cylinder full of water, and the pressure of the water is measured by a Richards indicator connected by a pipe to the cylinder; thus, as the drum of the indicator revolves, diagrams are obtained, giving the force acting on the piston. The advantages of this method are obvious, because the indicator can be placed at any convenient point and the inertia of the water tend to make the pencil keep a position corresponding to the mean force. A detailed description of the construction of the dynamometers has been given in the *Proceedings* of the Institution of Mechanical Engineers, but would occupy too much space in this *résumé* of the experiments.

Brake blocks were applied to both pairs of wheels, but the dynamometers were attached to one pair of wheels only. The greater number of experiments were made with this latter pair of wheels, the second pair being reserved for special experiments when the van was slipped from the engine.

The levers for bringing the brakes into operation were so arranged that the brake blocks were applied on both sides of each wheel, and the pressure was equally distributed between the four brake blocks, acting on the pair of wheels.

The dynamometers above mentioned registered (1) The pressure applied to force the brake blocks against the wheels. (2) The friction which took place between the brake blocks and the wheels, due to that pressure, measured by the effort made by the revolving wheel to cause the blocks to revolve. (3) The weight on the springs over the braked wheels at each moment during the experiment, which, added to the weight of the wheels, axles, and springs, gives the weight for calculating the adhesion. (4) The tractive force exerted by the draw-bar. (5) Two self-recording speed-indicators were used, designed by Mr. Westinghouse, one instrument being attached to each pair of wheels. This instrument has been repeatedly tested, and was used at the brake trials on the North British Railway and on the German State Railways. It consists of a small dynamometer made on the same principle as that just described; it measures the centrifugal force of two weights, which are made to revolve by a strap from a pulley on a shaft driven by friction-gear from the pair of wheels to which the brake was applied; a Richards indicator is used, as with the other dynamometers. As the centrifugal force varies as the square of the velocity, the speed is got by taking the square root of the ordinate at any point of the indicator diagram.

The diagrams from one speed indicator showed the speed of the pair of wheels to which the brake was applied, and therefore the velocity of the train at the moment of applying the brake and subsequently, provided there was no slipping. Any variation in the speed-diagram was due to the wheels slipping, and shows to what extent and in what way the brake acted to stop the wheels. The diagrams from the other speed indicator showed the speed of the unbraked wheels. A Bourdon gauge, with the face divided in such a way that the hand showed the speed in miles per hour, was attached, for convenience, to the Westinghouse speed-indicator. As a check upon these, two of Mr. Stroudley's speed-indicators were fixed side by side in the van; one attached to the axle belonging to the braked wheels, the other to the axle which was running free. These indicators do not record the speed.

The indicators were all placed on a table in the centre of the van, and their drums were made to revolve by the cords being wound up on pulleys on a shaft, which was turned at a uniform rate by a water clock. This clock merely consisted of a plunger sliding in a cylinder through a water-tight packing, and loaded with a heavy weight; it was wound up by connecting it with the accumulator which supplied the dynamometers, and at the beginning of each experiment a small cock was opened which allowed the water to run out and the weight to fall, thereby turning the indicators round at an ascertained uniform speed. Thus, while the ordinates of the diagrams taken from these several indicators show the various forces, the abscissæ show the time occupied in the experiments.

In most of the experiments the tyres were of steel, and the brake-blocks of cast iron. Some experiments were made with wrought iron blocks, but the results were not uniform or satisfactory.

Numerous diagrams were taken with this apparatus, but it will suffice here to give the general results arrived at.

It is convenient in looking at the question of railway-brakes to consider first, what is the operation of a brake?

A train through the adhesion of the wheels of the locomotive acting on the rails, slowly accumulates energy, and for each ton of weight in the train, the accumulated energy is equal to 120 foot-tons at 60 miles per hour, 53 foot-tons at 40 miles per hour, and 30 foot-tons at 20 miles per hour. Thus, for a train of fifteen vehicles, weighing 200 tons, the energy at 60 miles per hour is equal to 24,000 tons falling a distance of one foot.

After a train has attained the desired speed, the reasons for stopping it may be of two kinds: (1) at prearranged places for convenience; and (2) for the prevention of accidents or for mitigating the consequences if accidents are unavoidable.

To stop a train for the first reason requires but a limited amount of force, which may be applied in any crude manner.

For the prevention of accidents, however, there is required:—

a. The instantaneous application of the greatest possible amount of retarding force.

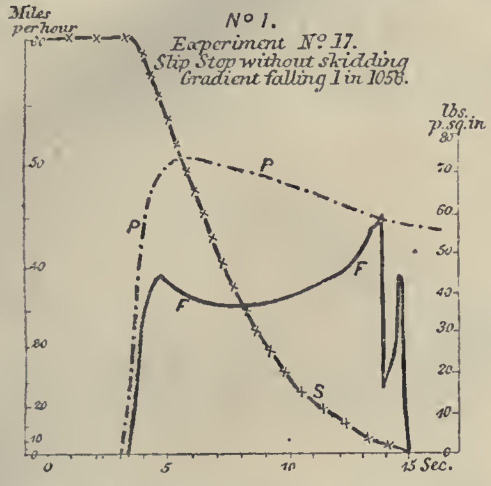
b. The continuous action of this force until the momentum of the train is destroyed.

The retarding force used in practice is that due to the friction resulting from the forcible application of pieces of metals or wood (brake blocks) to the tyres of the wheels; this friction impedes the rotation of the wheels, and tends, through the adhesion of the wheels to the rails, to destroy the energy stored in the train. The retarding force is therefore limited to the resistance obtainable between the wheels and rails.

It was at first customary to attach to a train, for purposes of retardation, a certain number of vehicles with extra weight, to which the brakes were applied; but since the question of retardation has become better understood, brakes have been applied to every vehicle, the means of applying these brakes being placed in the hands of both the engine-driver and the guard. The reason for this is that the maximum amount of retarding force can be obtained only by applying brake blocks to every wheel in the train, each block being pressed with sufficient force to produce a resistance to the rotation of the wheel just equal to the greatest possible friction between the wheel and the rail. This greatest possible friction occurs when the adhesion of the wheel to the rail is just about to be overcome by the superior effort of the brake blocks, which effort, if further increased, immediately begins to stop the rotating movement of the wheel, and thus causes it

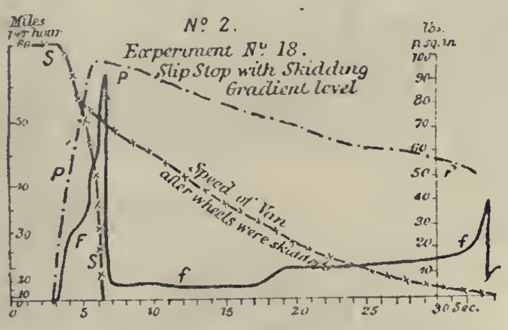
to slide upon the rail. The experiments were made with the object of measuring the force thus brought into action.

The first result of the experiments was to show conclusively that the retarding effect of a wheel sliding upon

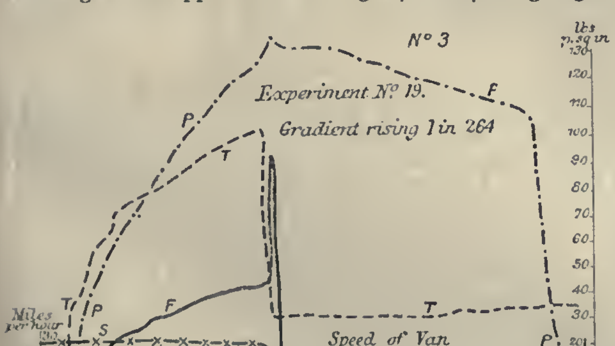


a rail is much less than when braked with such a force as would just allow it to continue to revolve.

The annexed copies of two sets of diagrams (No. 1 and No. 2) taken during the experiments show, more



clearly than can be explained, the difference in the retarding force before the wheels begin to slide upon the rails, and after. These two experiments were made with a single van slipped from the engine, the brakes going on



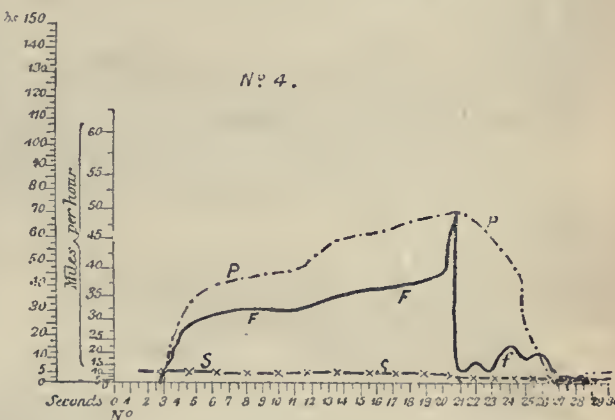
automatically when separation from the engine took place. S is a line showing the speed of the van at each instant, the scale for which is at the left side. P is the pressure against four blocks acting upon one pair of wheels; the vertical height of P by the scale on the right hand multiplied by 240 gives the total pressure in pounds on the four blocks. F is the line showing the retarding effect of the four blocks upon the one pair of wheels before the wheels began to slide upon the rails; and *f* shows the effect while the wheels were sliding upon the rails. The vertical height of F or *f*, according to scale B, multiplied by 60, gives the retardation in pounds. It will be seen that the stop was made in half the time with the wheels braked but not skidded of that required when the wheels were skidded.

The accompanying Diagram 3 shows in another way the comparative retarding effect of the brakes when acting on the revolving wheels and when applied with sufficient force to skid the wheels.

This experiment was made by keeping the van at a uniform speed on a rising gradient of 1 in 264—the line T shows the strain on the draw-bar during the experiment. The line S shows the speed of revolution of the braked wheels, when the revolution was checked and the friction diminished as shown by the line *f*; the strain, T, on the draw-bar diminished in a corresponding ratio.

From this it is evident that the retardation which arises when the wheel is sliding on the rail is far less than the retardation produced by the effect of the brake blocks when applied to the wheels so as to allow the wheels to continue revolving.

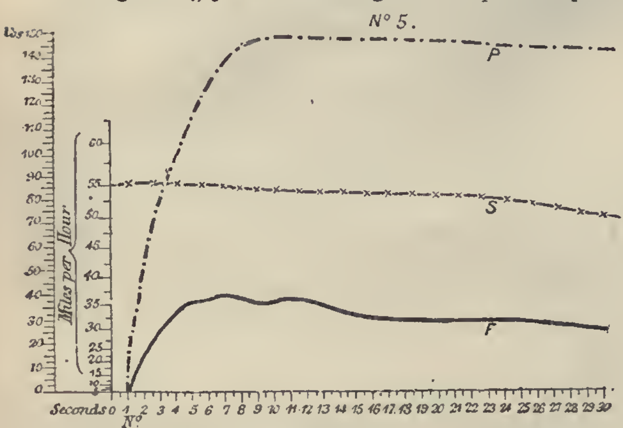
In order to understand this it is necessary to consider the general action of railway brakes. When a train is



moving at a given velocity the adhesion of the wheels on the rails causes them to revolve; every point on the surface of the tyre moves round at the same rate as that at which the train itself is moving forward; but every such point in relation to the forward movement of the train comes successively to rest at the moment when it comes in contact with the rail. Now when the brake is applied with a slight pressure only, the wheel continues to move round at the same rate as that at which the train is moving, but it moves with more difficulty, and this increased difficulty in moving is shown either by an increase in the tractive force required to keep up the forward motion, or, in cases where the accelerating force is not kept up, by the tendency of the moving mass to come to rest in a shorter time than would otherwise be the case. But if the pressure with which the brake is applied be increased, a point is reached when the friction between the brake block and the wheel first approaches, then equals, and finally exceeds, the adhesion of the wheel on the rail. When this happens, the wheel first begins to revolve more slowly, and then ceases to revolve and slides along the rail, or, as it is usually termed, is skidded. The retardation is then no longer due to the friction between the brake block and the tyre of the wheel; but the vehicle is transformed for the time from

a vehicle on wheels into a sledge, and the retardation is due to the excess of resistance which is produced by making the vehicle slide along the rails over that produced by making the vehicle move forward on wheels revolving freely.

The reason why the retardation caused by the brake blocks applied to revolving wheels exceeds that caused by the skidded wheels became obvious from the fact next discovered, viz., that the coefficient of friction between the brake blocks and the wheels varied inversely according to the speed of the train, a higher proportionate percentage of brake-block pressure being required to obtain a given amount of friction at high speeds, and a lower pressure at lower speeds. This is illustrated by the Diagrams 4, 5. In these diagrams P represents pres-

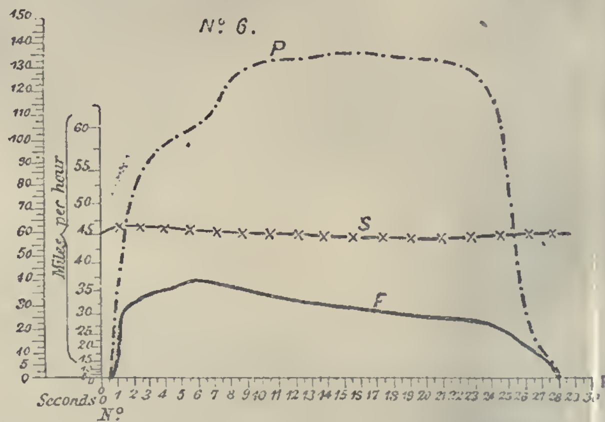


sure, F friction, and S speed, measured on the respective scales at the side to be corrected by the multiple before mentioned; it will be observed that the ratio of F to P in Diagram 4 with a speed of eleven miles per hour is much larger than that of F to P in Diagram 5 with a speed of fifty-five miles per hour.

The following table shows the coefficient of friction obtained from these experiments at varying speeds between cast-iron brake blocks and steel tyres:—

No. of experiments from which the mean is taken.	Velocity.		Coefficient of friction.		
	Miles per hour.	Feet per second.	Extremes observed.		Mean.
			max.	min.	
12	60	88	·123	·058	·074
67	55	81	·136	·060	·111
55	50	73	·153	·050	·116
77	45	66	·179	·083	·127
70	40	59	·194	·088	·140
80	35	51	·197	·087	·142
94	30	44	·196	·098	·164
70	25	36½	·205	·108	·166
69	20	29	·240	·133	·192
78	15	22	·280	·131	·223
54	10	14½	·281	·161	·242
28	7½	11	·325	·123	·244
20	Under 5	Under 7	·340	·156	·273
	Just moving		—	—	·330
Fleeming Jenkin		·0002 to ·0086	·337	·365	·351
Static friction (Rennie) 180 lbs. per square inch		—		—	·300
336 lbs. per square inch		—		—	·347

If the position of the brake-blocks were always the same at the same speed, some simple rule might be deduced which would give the pressure required at each speed for obtaining a certain amount of retardation; but when the speed of the van was kept nearly uniform by the effort of the engine, the friction of the blocks decreased; and this occurred notwithstanding a continued increase of the brake-block pressure: showing that, through some cause not yet fully determined, the holding-power of brake-blocks at all speeds is considerably less after some seconds of application than when first applied. This peculiarity is illustrated by Diagram 6, and is also



apparent in Diagram 5. Hence the question of the proper amount of brake-force needed at each instant, during the time required to stop a train, is still further complicated by this decrease which occurs in the coefficient of friction after the brakes have been applied, and which results from the time during which they are kept applied, irrespective of any change in speed. This decrease in the coefficient of friction is shown in the following table:—

Coefficient of Friction as affected by Time

Speed. Miles per hour.	Coefficient at commencement of experiment.	After 5 seconds.	After 10 seconds.	After 15 seconds.	After 20 seconds.
20	·182	·152	·133	·116	·099
27	·171	·130	·119	·081	·072
37	·152	·096	·083	·069	—
47	·132	·080	·070	—	—
60	·072	·063	·058	—	—

Diagram 7 shows the curves of this decrease obtained from a few of the experiments. It would seem as if the coefficient of friction due to each speed becomes nearly uniform after a certain number of seconds have elapsed. The experiments were, however, necessarily limited to something between twenty and thirty seconds each, so that this point has not been fully determined.

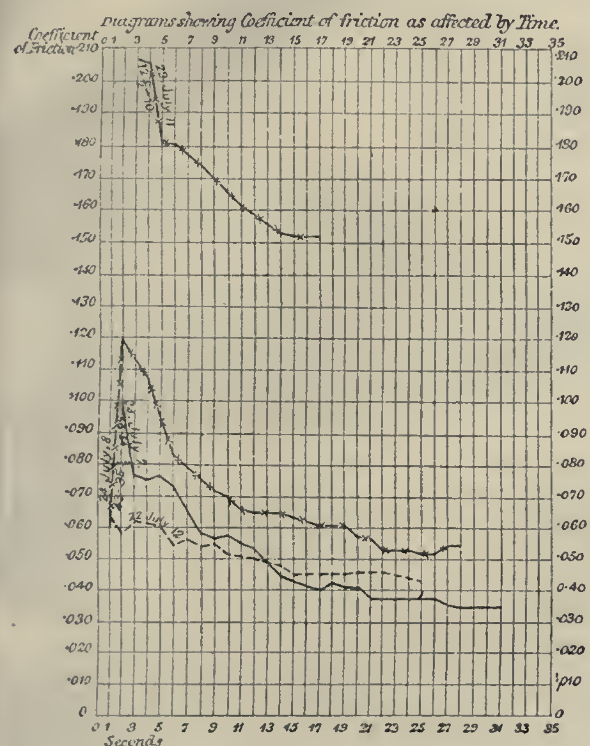
The decrease in the coefficient of friction, arising from time sometimes overcomes the increase in the coefficient of friction arising from a decrease in speed; especially when, either from the stop being on a descending gradient or from a small proportion of the train only being fitted with brake power, the train takes considerable time in coming to rest. Therefore, a higher brake pressure is required in such cases than when the stop is made in a short time.

The accompanying diagram (8) shows a uniform force of friction with a practically uniform speed, as obtained by means of an increasing brake-block pressure. The line P, shows the pressure, F the friction, and S the

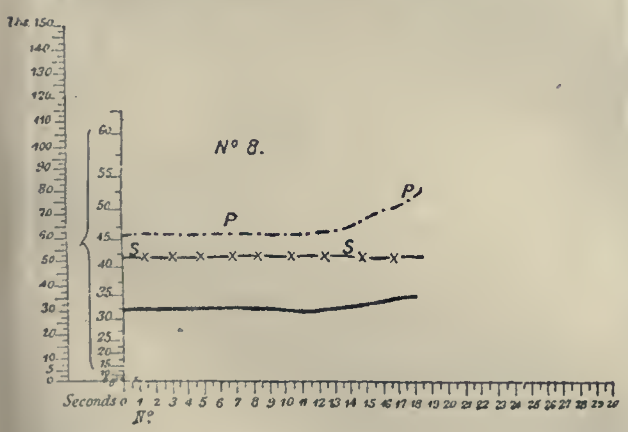
speed, which decreased slightly during the experiment, and would have caused an increase in the coefficient of friction had it not been counteracted by the element of time.

There is nothing unnatural in the fact that friction decreases with speed. Friction is mechanical work; it re-

Nº 7.

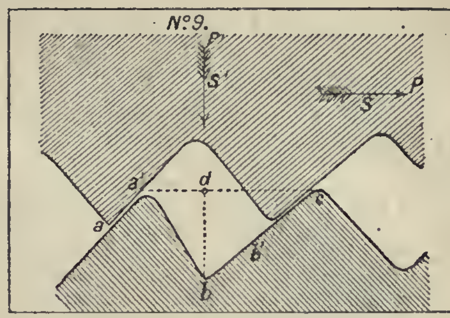


quires a definite force to move a body which is in contact with another, and such movement causes a perceptible wear of the surfaces in contact. The manner in which this work is accomplished can be explained only by the fact that the surfaces in contact are not perfectly smooth, but irregular, although this irregularity may not be distinctly visible to the naked eye. These surfaces, if exa-



mined under a sufficiently strong microscope, would be found to be somewhat as represented in the accompanying diagram, No. 9.

If the upper body be moved in the direction of the arrow, S, by a force, P, the point, *a*, of the upper surface would mount the incline, formed by the corresponding portion of the lower body, until it reached its summit at *a′*; from this moment it would begin to descend the next incline, from *a′* to *b*; provided the force, P, acting in the direction of the arrow, S, would leave it time to do so, the incline from *b* to *c* would have to be mounted next, causing a certain amount of resistance during the time the body traversed the distance *d c*. But if we increase the speed in the direction of the dart S, so that the body will require less time to traverse *a′ d* than to fall through *d b*, in such case *a′* would not arrive at *c*, but at some other point, *b′*, and then only the portion of the



incline *b′ c* would have to be mounted, presenting a smaller amount of resistance than in the former case. This illustrates what occurs.[1]

The fact that the coefficient of friction diminishes with speed sufficiently explains why a skidded wheel affords less resistance than one which still rotates, because the resistance occasioned by the rotating wheel is only limited by the adhesion of the wheel on the rail, and this, as already shown, is the same as static friction, since the point of the wheel is stationary as regards the forward movement of the train at the moment it touches the rail; whilst when the wheel is skidded and slides, the friction is that due to the speed at which the wheel moves on the rail, and is therefore less than the other.

DOUGLAS GALTON

(*To be continued.*)

GEOGRAPHICAL NOTES

ON Monday the French Geographical Society held an extraordinary meeting, in the large hall of the Sorbonne, for the reception of Major Serpa Pinto, the African explorer. We understand that Major Serpa Pinto and Lieut. Lucien N. B. Wyse have both promised to attend the coming meeting of the British Association at Sheffield, and will give accounts of their recent explorations in Africa and the American Isthmus. Some other very interesting papers, we hear, are in preparation for the geographical section, over which Mr. Clements R. Markham will preside.

THE principal novelty in this month's Petermann's *Mittheilungen* is an elaborate paper "On the Geographical Distribution of some Plague Epidemics," by Dr. Carl Martin. Dr. Emin Bey has a short paper "On the River Obstructions of the Bahr el Jebel," and we regret to say, Dr. Gerhard Rohlfs writes from Bengazi on June 10, that he has resigned the leadership of the expedition of the German African Society, which was organised for the purpose of reaching the Congo by starting from Tripoli. Dr. Rohlfs gives as his chief reason for resigning, the length of time the expedition is likely to last, and the value of even a single year at his age. He has, however, done his best to remove all difficulties from the way of the expedition in setting out, and these have not been few. He proposes Dr. Stecker to succeed him, and hopes the

[1] This simple illustration is taken from an article in the *Chicago Railway Gazette*, by M. Krajewski.

Society will approve. Though Dr. Rohlfs' resignation is to be regretted, he cannot be blamed, and we trust the expedition will be able to carry out its original programme.

THE French Government will present to their Parliament a bill for taking preliminary steps in order to establish a Soudan railway from Algiers to Senegal, *viâ* Timbuktu. An official commission has been appointed to report on that subject.

THE *Engineering and Mining Journal* states :—At a late meeting of the New York Academy of Sciences, Prof. Arnold Guyot, of Princeton College, presented before the Geological Section a paper upon "The Topography of the Catskills," containing the results of several years of study of these mountains, and which he is about to publish. From the contents of this interesting paper, it will appear, that this region of country—in the midst of the oldest settlements, and long celebrated as a summer resort—has remained comparatively an unknown wilderness, even to this day; for Prof. Guyot, within the past few summers, has actually discovered and named an extensive group of mountains rising into peaks in some cases over 4,000 feet high (the "Southern Catskills," or "Shandakeens"), which are not laid down on any map, or described in any gazetteer. These works of reference refer to this region as "a hilly country," merely, and the fact that it contains mountains higher than the true Catskills, is quite new to science, and it has been reserved to Prof. Guyot to make an interesting geographical discovery in the very heart of the State of New York. For the paper *in extenso* our readers are referred to the *Proceedings* of the Academy, and for a fuller abstract, to the *American Naturalist* for July, to which we are indebted for the brief notice here given.

CAPT. JAMES B. EADS, who is constructing the jetties to deepen the channel at the mouth of the Mississippi River, has written a letter to the *New York Tribune*, in which he proposes to substitute for the contemplated ship canal across the Isthmus of Darien a railway by which the largest vessels may be conveyed across in twenty-four hours. This project he claims to be entirely practicable, and says it would cost considerably less than the canal, and might be completed in three or four years. The ship could be raised by a lock and the usual hydraulic methods, and he suggests two methods that are practicable, and with precautions to prevent straining. He recommends turn-tables instead of curves in the railway where changes of direction are necessary. The car, or cradle, to carry the ship should be built in sections, each about 100 feet long, and each section supported by about 200 wheels, some of them driving wheels moved by engines. The weight of the largest merchant steamers and their cargoes would not exceed 10,000 tons. Such a vessel Capt. Eads would place on five of these sections, supported by 1,000 wheels bearing on eight or ten rails, so that each wheel would support about 12 tons. He thinks his plan entirely practicable, and urges it very strongly. Indeed the scheme adopted at the recent conference for an interoceanic canal meets with no favour in America, and Mr. Troutwine thinks it will never be finished, the difficulties are so great. Perhaps national, as much as engineering reasons, influence American opinion on the subject.

DR. H. A. A. NICHOLLS, who, we believe, is Surveyor-General of Dominica, has addressed to the *Colonies and India* some notes of considerable interest on that little-known island and its boiling lake. In many parts, he tells us, fine undulating uplands extend from the heads of the valleys far into the interior, and one runs across the broadest part of the island at an elevation of 800 feet above the sea, containing many thousands of acres of fine, well-watered land, with a virgin forest of lofty timber trees. The chief mountain peak reaches a height of 4,747 feet. Only a small portion of the island is cultivated, but of the rest, which is covered with the primeval forest, large tracts are suited for the growing of coffee, cocoa, spices, limes, and other tropical products. The Boiling Lake, which is at an elevation of 2,425 feet above the sea, has been visited on three occasions by Dr. Nicholls, who, on his second visit, ascertained that the temperature at the edge was 180° F., gradually increasing towards the centre. The lake was first seen in recent times by an exploring party organised and led by Mr. Watts, a colonial magistrate, and Dr. Nicholls. They thought they were its discoverers, but it has been found that the volcano is mentioned in a very rare medical work published in 1797.

PROF. GEORG GERLAND concludes in the current number of *Globus* a long and elaborate examination into the future of the American Indians. The conclusion he comes to is that facts do not warrant the inference that the Indians are dying out, nor that they have been deleteriously affected by contact with civilisation.

IN the course of this month a highly interesting geographical work will be published by Karl Graeser, of Vienna, by order of the Austrian Minister for Education. Its author is Prof. Friedrich Umlauf, and its title "Wanderungen durch die oesterreichisch-ungarische Monarchie; landschaftliche Characterbilder in ihrer geographischen und geschichtlichen Bedeutung."

THE second International Congress for Commercial Geography will take place at Brussels from September 27 to October 1 next. It will be divided into five sections; the first will consider commercial routes and exploring expeditions, the second natural and artificial products, the third and fourth questions relating to emigration, colonisation, and instruction, while the fifth section will be devoted to the discussion of general questions.

HERR CARL BOCH, who has now finished his natural history exploration of the western highlands of Sumatra, is about to explore, on behalf of the Dutch Government, the north-eastern part of Borneo—the district of Koetai. There is a powerful and friendly Sultan at Koetai, who has been requested by the Dutch Government to give all possible assistance to Herr Boch.

ONE of the newest of French geographical societies, that of Montpellier, which has assumed the title of Société Languedocienne de Géographie, now publishes a *Bulletin* about every two months, which for size is imposing enough, for the last number runs to 180 pages. It contains, among other matter, observations on the creation of an inland sea in the Eastern Sahara, and papers on Natal, the Transvaal, and Zululand, and on the River Ogowé, as well as a summary of M. Soleillet's account of his recent attempt to reach Timbuktu, *viâ* Ségou.

A NEW project for the construction of a system of canals connecting the Caspian Sea with the Black Sea is now being considered by the Russian Government, and is discussed in a recent number of the *Journal* of the Russian Imperial Office for Public Works of Communication. The author of the new project is the engineer, M. A. Daniloff. He proposes to construct (1) a canal of some 300 versts in length, from the River Terek to the water-shed of the River Manytsch, which connects the Don with the Caspian Sea, but the bed of which is generally dry; (2) a canal of about 320 versts, from the mouth of the River Kalans (a tributary to the Manytsch), eastward to the Wolga, near Astrachan; (3) a canal from the same spot, westward to the Don (about 350 versts); (4) a branch from the eastward canal to the Serebriakowskaya Station on the Caspian Sea; (5) a branch from the westerly canal to the Black Sea. Other Russian news states that the Government has commanded the Khan of Khiva to furnish 5,000 workmen for the works connected with directing the Oxus River into the Caspian Sea.

PROF. MOEBIUS ON THE EOZÖON QUESTION[1]

II.

HAVING described the Eozöon sufficiently to enable the reader to follow its comparison with foraminifera, Prof. Moebius proceeds to the description of the structure of these animals. Fig. 12 represents a longitudinal section of *Tinoporus baculatus*, magnified 150 times. This foraminiferal species occurs very frequently upon the coral reefs of the Samoan Islands in the Pacific. Its shell consists of a bi-convex middle part, from which at

FIG. 12.

least four or five spines radiate, all of which are situated in the principal plane of the body of the shell. At C two shells of *Tinoporus* are drawn, magnified three times.

[1] Continued from p. 275.

In the centre of the larger figure we see the globular germ-chamber of the animal (K*a*) round which the next

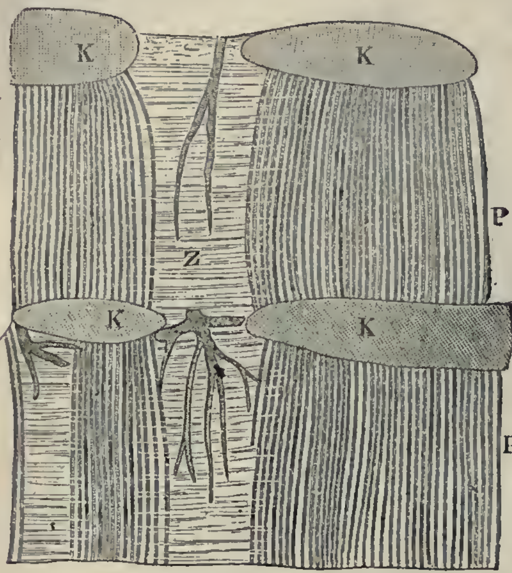


FIG. 13.

FIG. 14.

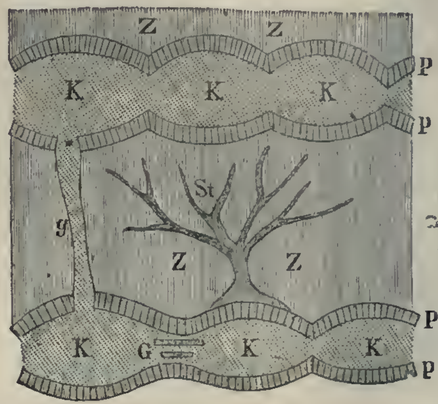


FIG. 15.

following chambers (K) are spirally arranged. Then in four directions curved rows of chambers (K) are formed, which are separated by intermediate matter (Z). The chambers communicate with each other, partly by round passages (G), partly by pore-canals (P). Through the intermediary matter (Z) a canal-system is extended, which in the long arms of the shell ends in many minute canals opening to the surface (K*l*). Through the pores of these little canals, as well as through the orifices of the peripheric pore-canals (P) of the outer rows of chambers, the sarcode, *i.e.*, the gelatinous body-substance of the animals, is in communication with the outside. In some parts protruded, granular sarcode filaments are represented (S, S); these are the so-called pseudopodia. At C we see two chitinous chamber-linings with adherent linings of pore-canals, magnified 350 times; at *d* are drawn chitinous ducts from the canal-system in the intermediary matter, also magnified 350 times, and freed from lime by treatment with dilute chromic acid. Fig. 13 represents a small part of a cross section of a tertiary *Nummulina*, magnified 220 times. K K are the chambers which were filled with sarcode. The superposed chambers communicate by means of pore-canals (P P). Between the chambers there is a deposit of poreless intermediary matter (Z), into which ramified canals are penetrating. Fig. 14 shows five pore-canals, magnified 500 times. Here it is seen distinctly that they are round tubes separated by calcareous matter. Some of them are partly filled with a dark material.

According to Dawson and Carpenter the limestone of the Eozöon represents the shell of the Eozöon animal, and the serpentine the material filling the chambers. Thus the serpentine now takes the place of the sarcode which once lived in these chambers, and which from its substance secreted the lime as a shell. The serpentine patches of the fossil Eozöon, according to this view, have the same shape and size which the separate chamber bodies of the living animal possessed when fully extended.

The separate fibres of the bands lying between the limestone and the serpentine, according to Dawson and Carpenter, are the siliceous fillings of the minute canals through which the sarcode body could send pseudopodia-filaments into the water outside of the shell. The simple

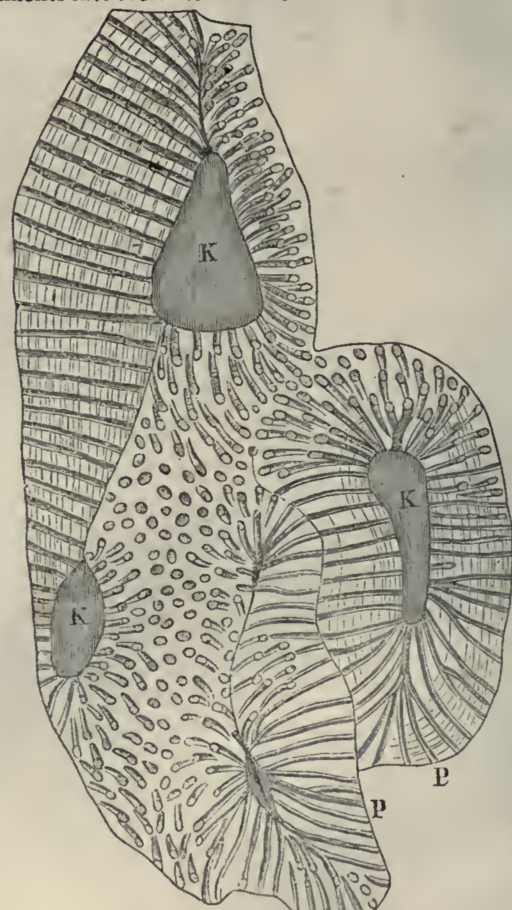


FIG. 16.

and the ramified stems in the limestone are siliceous

fillings of canals in which the Eozöon sarcode extended through the calcareous intermediary matter.

Dr. Carpenter represents this view of the different parts of Eozöon by a systematic drawing, which we give in Fig. 15. K, K, K are two rows of chambers filled with serpentine. The narrow parts between the chambers correspond to the round passages of foraminifera. In the lower row of chambers, at G, the communicating passage between two chambers is divided into three narrow ducts by two plates which lie embedded here. P, P represent the walls of the chambers penetrated by the fine pore-canals, in the places of which in the real Eozöon fibres of chrysotile are now situated. Z, Z is the intermediary matter of the Eozöon shell, into which the ramified canals (St) (the present stems of the Eozöon) are protruding. Towards the left, at *g*, a chamber duct is represented, which unites two chambers of different rows or layers. Chamber ducts of this kind occur in *Tinoporus baculatus* (Fig. 12), for instance, and also in other living foraminifera.

Prof. Moebius then proceeds to compare one by one the different parts of Eozöon with those parts of foraminifera to which, according to the views of Dawson and Carpenter, they are supposed to correspond.

1. If the patches of serpentine are the filling materials of the Eozöon chambers, then they represent their cavities plastically in a similar way, as the stone kernels of echini, gasteropoda, and ammonites represent the interior cavities of the shells of these animals.

The relative sizes of the serpentine patches vary very much. The longitudinal axes of the largest ones are about thirty times as large as those of the smallest. Their absolute sizes vary from a few millimetres in length and 0·5 mm. in height, to 20-30 mm. in length and 5–10 mm. in height.

The serpentine patches of Eozöon are in form and arrangement, as well as in relative size, very unlike the chambers of most foraminifera. In their shapes none of the fundamental forms are reproduced again and again, which in all the chambers of a foraminifera species point back to one and the same law of formation. Neither the fundamental shape of a ball or lentil, nor the shape of a crescent or sickle, which occur in the different foraminifera species, form the basis of the serpentine patches of Eozöon. Yet there is a certain regularity in their shape and arrangement. Frequently they have contours similar to crystals of olivine (Fig. 10). Generally they form concavo-convex layers which are superposed and are separated by layers of limestone (Fig. 1). In many pieces an increase in size of adjacent serpentine patches in one direction may be observed. In many others ball-shaped or oval serpentine patches are arranged in such a manner that they form a spiral (Figs. 3 and 4). But this arrangement does not give the impression of a *genetic* succession, as is the case with the chambers of spiral foraminifera.

2. The fibres, forming band-like spaces between the serpentine and the limestone are supposed to be the siliceous fillings of fine pore-canals which penetrated the calcareous chamber-walls of the Eozöon shell.

Fig. 17.

The pore-canals in the chamber-walls of foraminifera are cylindrical tubes, separated by calcareous intermediary matter. Thus every tube runs *isolated* through the chamber-wall (Figs. 12, 13, and 14). The fibres of the Eozöon, however, are prismatic needles or little plates, which are situated close together (Figs. 10 and 11), and

Fig. 18.

therefore they cannot represent the fillings of cylindrical tubes in another material. In no sections, neither in those which cut through them at right angles, nor in others which exhibit them obliquely, nor in those which are parallel to their axis, any traces of an intermediary substance separating the single fibres can be found. Also in polarised light the fibre bands appear altogether homogeneous and consisting only of *one* kind of material.

The pore-canals penetrate the chamber-walls of the foraminifera in such a direction that to the sarcode filaments, which, as pseudopodia are sent forth from the chambers into the water outside, they offer the shortest possible way (Figs. 12 and 13). Thus as a rule they lie at right angles to the inner and outer surfaces of their

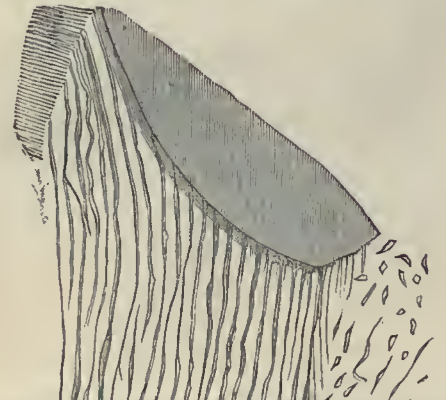


FIG. 19.

chamber-wall, as long as this continues to get uniformly thicker by the deposition of regular layers. If the thickening of the chamber-walls takes place in an irregular manner, then it often happens that the pore-canals are curved; yet even in this case the tendency of the sarcode to reach the outside water through the new thickening layers of its chamber-wall by the shortest possible way becomes apparent. This law is manifest even with the simplest forms of foraminifera, the chambers of which are not even of regular shape and arrangement. Fig. 16 illustrates this; it represents a section of *Carpenteria rhaphidodendron* magnified 120 times; K K are chambers, P P pore-canals.

In the direction of the Eozöon fibres, which are supposed to correspond to the pore-canals of foraminifera, a similar organic regularity is altogether missing. It is true that in many places they radiate from the surface of the serpentine patches, which are supposed to be the fillings of foraminifera chambers, at right angles towards the limestone; yet the direction of the fibres in these places cannot be said to represent the direction of the sarcode of a foraminifera species, because in adjacent parts the direction of the fibres does not always obey the same law, and because for great distances in the fibre bands all the fibres retain a parallel direction, no matter whether they lie at right angles, obliquely, or even tangentially to the serpentine patches. This is shown in Fig. 17, representing a section of Eozöon magnified ninety times; in the centre is a serpentine patch, S, surrounded almost on all sides by parallel chrysotile prisms; above to the right there is a smaller patch of serpentine, surrounded by chrysotile fibres of the same direction. The pseudopodia of a living sarcode mass, which once took the place of the serpentine, cannot therefore have determined the direction of the fibres; on the contrary, their parallelism points to an *inorganic* origin, because it is independent of the curvatures of the boundaries between serpentine and limestone.

3. The stems in the limestone of the Eozöon are supposed to be the siliceous fillings of ramified canals in the intermediary matter of the Eozöon shell. In good sections the stems generally look brownish in transmitted light; whitish or colourless ones are much less frequent. Their shape, size, direction, and quantity vary extremely, not only when different sections are compared, but very often already in different parts of the same section, even if this measures only a few millimetres in length and breadth. The stems may lie so close together that the spaces intervening are hardly larger than their own diameters (Fig. 18); often they are separated by wide intervals (Figs. 5 and 18). Sometimes they run parallel (Fig. 18), at other times they radiate from one or more points, or assume the shape of feathers (Fig. 19). They touch the boundaries of the limestone or are imbedded in the midst of this (Figs. 5 and 18); they are simple (Figs. 18 and 19) or ramified (Figs. 5, 9, 10, and 18), long and slender or short and broad. They terminate in fine points or in the shapes of clubs or spoons. They are straight, bent into knee shapes, curved like waves, or folded and twisted irregularly.

Their sections generally have sharp edges; round or elliptical sections, like those of the ramified canals of foraminifera, are rare amongst them. The sizes and shapes of successive sections of one and the same stem may also vary considerably.

Prof. Moebius concludes his treatise with the following characteristic sentences:—"My task was to examine Eozöon from a biological point of view. I commenced it with the expectation that I should succeed in establishing its organic origin beyond all doubt. But facts led me to the contrary. When I saw the first beautiful stem-systems in Prof. Carpenter's sections, I became at once a partisan of the view of Professors Dawson and Carpenter; but the more good sections and isolated stems I examined, the more doubtful became to my mind the organic origin of Eozöon, until at last the most magnificent 'canal-systems' taken all together and closely compared with foraminifera sections preached to me nothing but the inorganic character of Eozöon over and over again.

"In the minds of other zoologists, while showing them a series of my finest Eozöon sections, stem preparations, and foraminifera sections under the microscope, I have repeatedly in the course of an hour called forth these mental metamorphoses, which I passed through in the course of a long period of investigation.

"I am heartily sorry that, by way of thanks for the extremely kind support which Professors Dawson and Carpenter have given me in these investigations by

sending me beautiful Eozöon pieces, I cannot say to them: According to my investigations also *Eozöon canadense* must be regarded as a fossil species of foraminifera. I am convinced that both, like myself, had the honest intention to represent correctly the true nature of Eozöon. But they must own that in their descriptions they did not investigate so closely nor describe so minutely the shapes nor the relative positions of the various parts, as I have done in my treatise. If they had done this then I believe that the facts would have led them to the same conclusions which they forced upon me.

"If the Eozöon pieces from the Laurentian or 'Urgneiss' formation were really remains of an undoubted foraminifera species, then we should possess in them *certain* proofs that even during the formation of the most ancient strata of the earth's crust living beings occurred, and that the first organisms belonged to the lowest animals, by which biology and geology would have gained two highly important facts. Yet by the scientifically justified elimination of Eozöon from the domain of organic beings it is not proved that during the Laurentian period no living beings existed. Perhaps the graphite of the Urgneiss formation has its origin in organic beings.

"The proof that Eozöon is not a fossil rhizopod will perhaps for many persons take away an important link from the beautiful picture of the development of organic life upon the earth, which they may have drawn up for themselves. But the object of natural research does not consist in finding reasons for attractive conceptions about nature, but in knowing nature as it really is. Because only an insight into the real condition of nature can, in the long run, satisfy the scientific mind, which gives up as errors the most attractive hypotheses regarding the essence and action of nature, if in the face of newly discovered facts they can no longer hold good, no matter whether these erroneous hypotheses may have reigned supreme for a long time previously, and may have been held to be the best conceptions of nature by the most eminent authorities."

THE BLOWPIPE CONE-SPECTRUM, AND THE DISTRIBUTION OF THE INTENSITY OF LIGHT IN THE PRISMATIC AND DIFFRACTION SPECTRA

NOW that the optical properties of the blowpipe blue cone have been so critically investigated, may I draw the attention of the readers of NATURE who are interested in the history of spectrum analysis, to what I think are the earliest experiments on that subject. They were published by me in 1848. The memoir in which they are reprinted may be found in my "Scientific Memoirs." It contains a woodcut of the five rays, adjusted to a reference solar spectrum on page 64, and another of the five images of the cone on page 69.

Let me also refer to some experiments I have recently made on the distribution of the intensity of light on the spectrum, by the aid of a new form of spectrometer, which depends on the well-known optical principle, that a light becomes invisible when it is in presence of another light about sixty-four times more brilliant.

In a memoir I am now publishing in the *American Journal of Science*, and which, I presume, will also appear in the *Philosophical Magazine*, I have described several modifications of this instrument. The following is one easily made:—

Remove from the common three-tubed spectroscope its scale-tube, and place against the aperture into which it was screwed a glass ground on both sides. In front of this arrange an ordinary gas light attached to a flexible tube, so that its distance from the ground glass may be varied at pleasure. This light I call the extinguishing light. On looking through the telescope-tube the field of view will be found uniformly illuminated, this being the use of the ground glass, the light of which is reflected from the prism. The brilliancy of the field depends on the distance of the extinguishing light from the ground glass, according to the ordinary photometric law.

Now, if another small gas flame be set before the slit of the instrument, on looking through the telescope its spectrum will be seen in the midst of a field of light. If the illumination of that field be made very brilliant, the spectrum will be extinguished; if feeble, all the coloured regions appear. By moving the extinguishing flame to proper distances, it will be found that the violet region is the first to disappear, the red the last. The yellow by no means resists longest, as it ought to do if it were the most brilliant. Hence it follows that in the prismatic spectrum, the red and not the yellow is the brightest ray.

If the cause of the increasing intensity of light in the prismatic spectrum, from the more to the less refrangible region, be the compression exercised by the prism on the coloured spaces, increasing as the refrangibility is less, we ought not to find any such peculiarity in the diffraction spectrum. In this the coloured spaces are arranged uniformly, and without compression in the order of their wave-lengths. An extinguishing light ought to obliterate them all at the same moment.

Having modified the common spectroscope by taking away its dark box, so that the slit-tube and the telescope tube could be set in any required angular position to each other, I put in the place of its prism a glass grating, inclined at 45° to rays coming in through the slit. The ruled side of the grating was presented towards the slit. Now when the extinguishing flame was properly placed before its ground glass, the plane face of the grating reflected its light down the telescope-tube. In this, as in the former case, the spectrum of a small flame before the slit was seen in the midst of a field of light, the intensity of which could be varied by varying the distance of the extinguishing flame. It was now found that as the brilliancy of the extinguishing illumination increased, all the coloured spaces disappeared at the same moment, and on diminishing the illumination all the colours came into view at the same time. As long as the red was visible the violet could be seen.

From this it follows that in the diffraction spectrum the luminous intensity is equal in all the visible regions. In the memoirs now publishing I have applied these facts to the case of the spectrum distribution of heat.

JOHN WILLIAM DRAPER

University of New York

THE NEW THERMO-ELECTRIC LIGHT BATTERY

IT appears that a difficulty which it has long been the ambition of practical electricians to overcome has at last been solved by M. Clamond. According to his statement, published in *La Lumière Electrique*, which is confirmed by the Count du Moncel, M. Clamond has succeeded in producing the electric light by means of his new thermo-electric battery. M. Sudré has also just published his design for a powerful thermo-electric battery, but we do not know whether this system has yet been put to any practical trial, whereas that of M. Clamond is now in actual use for the purpose of lighting certain factories in Paris. Full details of either system have not yet come to hand, so that it is only possible to state the general results at present obtained.

That heat could be transformed into electrical energy was first discovered by Seebeck in 1822, who found that an electric current was produced when the junction of two dissimilar metals was heated. Little use, however, was made of this discovery as a source of energy, owing to the feebleness of the current to which it gives rise, although it has been of great service since the time of Forbes and Melloni in the investigation of radiant heat.

Prof. Bunsen, by the employment of different metals from those hitherto tried, found that he could increase the strength of the current, and M. Marcus, of Vienna, using alloys instead of simple metals for the positive and negative element, reduced the cost, while increasing the power of the battery. From a thermo-electric battery constructed on his principle, and also from a modified form, devised by Wheatstone, a current sufficiently strong to produce brilliant sparks, decompose water, &c., was obtained. This was in 1865, and but little progress has, until now, been made in this branch of science, with the exception of the improved forms of thermo-pile devised by Noë and by Messrs. C. and L. Wray, although the utilisation of heat—especially solar heat—for the production of electricity has long attracted the thoughts of many experimenters.

M. Clamond has for some time been at work upon the subject, and has so far succeeded that his thermo-electric battery has been employed since 1875 in M. Goupil's factories. These batteries are formed of iron, as the electro-positive element, and an alloy of antimony and zinc for the negative; they are soldered together and arranged in a circular form, which can be built up as high as may be desired. The junctions of the metals are heated in the interior, but the electromotive force being proportional to the difference of temperature between the two extremities of each bar, it was necessary to make the bars long if a strong current was desired, and then the results were less satisfactory, owing to the increased internal resistance, the melting of the metals where they were soldered, &c.

It is these hindrances to its extended use which M. Clamond has sought to obviate in his latest form of battery, which is composed of three distinct parts. The *collector* consists of a number of pieces of cast-iron so arranged that the heated air can circulate within them; a large surface is thus exposed to the heat, which the iron collects and communicates to the couples. The *diffuser* is the outside of the apparatus, and is made of sheets of metal. The *thermo-pile proper* is placed between these two, and is so arranged that the junctions of the metals are alternately at the temperature of the collector and the diffuser. Heat passes from the collector to the diffuser along these couples, which have no great length. In some forms which are very easily worked, a number of these couples are made into a flexible chain of any desired length, the extremities forming the poles of the battery. These chains, insulated from the other parts of the apparatus, can be united to each other by their free ends, so that a variety of couplings and combinations may be made. The model now in use for lighting a workshop in Paris is about 2½ metres high, and 1 metre in diameter, the exterior form being that of a polyhedron, to the sides of which the thermo-electric chains are attached; these are composed of small cubes of zinc and antimony joined together by plates of tin, to which they are soldered. Each half of the apparatus has 30 chains of 100 couples each, or 6,000 couples in all. To the outer surface of these chains are fixed the sheets of copper which form the diffuser or heat distributor.

Another model, made for the recent exhibition at the Albert Hall of the various systems of electric lighting, is square and much smaller, though of the same power.

Each half of the cylindrical battery can be made to supply a powerful electric light, while the square one can produce *four* lights of half the brilliancy. The electromotive force is, according to prolonged experiments, 218 volts, about equal to 120 Bunsen cells, while the resistance is 31 ohms. The large battery consumes only 9 or 10 kilogrammes of coke an hour, and the smaller one even less, about 6½ kilogrammes. Moreover, the large exterior surface of the apparatus radiating its heat to the air around adapts it admirably for use in heating, as well as for lighting, and it can thus be made to serve the double purpose of giving warmth and light.

M. Sudré has also designed his thermo-pile with a view to obtaining one of small volume and having a low internal resistance; the other peculiarities of his battery consist in the manner in which one set of junctions are heated while the other set are cooled. He has also determined what is the best length for the bars forming the couples, in order that the necessary difference of temperature at the two extremities may be maintained, while yet making them as small as possible. This he finds should be from 10 to 30 millimetres, according to the difference of temperature required. His manner of soldering together the two different metals is also novel and ingenious. In order that contact may be made with the whole surface of the bar, he cuts the plate, forming one metal, into the shape of a comb, twisting the teeth of this comb together, thus retaining a large surface, which yet has only a short length. The bars are fastened on to these twisted parts and the uncut part of the plate is coated with silicate of soda. The couples are formed in a mould in which the plates are fixed, the melted alloy is then run into the mould so that a block is formed of the alloy and the plates, firmly united. These chains or blocks are then placed between two plates, coated on one side with enamel or other electrically insulating substance; several chains may thus be arranged side by side, each chain being both calorically and electrically insulated. The parts of the chain are electrically insulated by the thickness of the plates, but heat can flow across the couples. The chains are next placed between a collector and a diffuser; the collector is ribbed if the source of heat be gas, in order to expose a greater surface. The diffuser is also ribbed for the same reason when the heat is merely allowed to radiate into the air. The whole battery is so arranged that the collectors form the inside of a circle within which the heated air is circulated.

BIOLOGICAL NOTES

THE BLOOD OF THE LOBSTER.—This liquid has been recently examined by M. Fredericq (Belgian Academy's *Bulletin*, No. 4), whose researches on the octopus were recently published. He finds in it as a rule two colouring matters, one blue, an albuminoid, coagulated by alcohol and heat, and apparently identical with the *hæmocyanine* found in the blood of the octopus; the other of rose colour, and soluble in alcohol (not always present). The former loses its blue colour in vacuo, and recovers it when acted on by oxygen, and it contains copper. The blood of the lobster is rose when it is reduced; exposed to oxygen it takes a special tint, blue with reflected light (hæmocyanine), brown with transmitted light (rose matter). It coagulates spontaneously and therefore contains fibrine. The blood of certain Gasteropoda (*Arion, Helix*) is also found to contain hæmocyanine, whereas M. Fredericq has not found it in the Lamellibranchiata (*Unio, Anodonta*). The general conclusion is reached that in such different groups of invertebrates as cephalopod and gasteropod molluscs, crustacea and annelids, as well as in vertebrates, respiration is effected by means of metalliferous proteic substances (hæmoglobin, hæmocyanine, chlorocruorine) which form in the respiratory organ (branchia, lung) less stable oxygenated combinations. These latter are dissociated in their passage through the tissues. In invertebrates, the two great functions of the blood, respiration and nutrition of tissues, belong both to the plasma, the corpuscles having a quite accessory importance. In the blood of vertebrates there is, in this respect, a division of physiological work; the respiratory function devolves upon the corpuscles, the nutritive function on the plasma.

ANNELIDS OF THE VIRGINIAN COAST.—Mr. H. E. Webster has just published an account of the Annelida Chætopoda which were collected in the summer months of 1874 and 1876 by the zoological expeditions sent out

under the auspices of Union College, Schenectady, N.Y. (in advance of vol. ix. of the *Transactions* of the Albany Institute, pp. 1-72, plates 1-11). The locality was on the eastern shores of Virginia (Northampton); between the mainland and the islands a large area of dark mud is exposed at low water. It is described as abounding in animal life, and yet the number of species of Annelids described is not large, there being only fifty-nine, relegated to forty-nine genera; of these, four of the genera are new, and twenty-seven of the species. The absence of Mediterranean species seems noteworthy, scarcely any of Ehler's species from the Adriatic or Claparède's, from the Bay of Naples, being quoted.

ACID REACTION OF FLOWERS.—It was stated, as the result of observation, by MM. Fremy and Cloëz, that the juices of all red and rose-red flowers showed an acid reaction, whereas the juices of blue flowers were always neutral, or even weakly alkaline. The subject has been studied afresh by Herr Vogel, who examined 100 species, viz., 39 blue, 44 red, 6 violet, 8 yellow, and 3 white flowers. The experiments (described to the Munich Academy) confirm the view that it is not warrantable to attribute the red colouring of flowers to action of acids or acid salts on blue colouring matter, or to attribute the latter to the influence of alkalies on red colouring matter, though doubtless there is a certain relationship between certain red and blue plant colours. It further appears that the opinion that plant juices generally, and even the majority of flower-juices, have an acid reaction, is pretty correct; among 100 flowers there were only twelve which did not react acidly. On the other hand, the rule above referred to is not found to apply universally, for among thirty-eight blue flowers twenty-eight showed a decidedly acid reaction, though the degree of the acidity was less than in red flowers.

FUNCTION OF SOME CONTRACTILE VACUOLES IN INFUSORIA.—An observation recently published by Herr Engelmann, of Utrecht, throws light on the function of the contractile vacuole in some infusoria. Some time ago he found a new infusory animal, closely allied to *Chilodon cucullulus*, and which he calls *Chilodon propellens*; it is marked by its slender form, and by the round shape of its hinder extremity, where is the contractile vesicle. This animal swims with pretty constant, but very slow, velocity in circling paths. Each time the vacuole contracts (which occurs in pretty regular intervals of about half a minute, and very quickly) there is an impulsive acceleration of the forward motion. If the animal be at rest, it makes, at the moment of systole, an impulsive forward movement about a quarter of its length. No simultaneous acceleration of the very sluggish ciliary movement was observed. The forward motion, then, can only be attributed to the backward thrust of liquid expelled from the contractile vacuole. Herewith agrees the fact that the hinder portion of the body shrinks together, in systole, as though to a thin empty sack folded in longitudinal direction, without the least perceptible increase in volume of the forepart of the body; so that the greater part, if not the whole of the liquid contents of the vacuole, must have been ejected behind. The re-expansion of the vacuole takes place very slowly, and it could not be determined whether liquid was directly drawn in from without. Coloured liquids were never observed to enter the vacuole.

PHYSIOLOGICAL ACTION OF COPPER. — For some years past the majority of medical men have no longer considered salts of copper as true poisons, their innocuousness being partly due to the fact that when they are taken in any considerable quantity, they cannot be kept in the stomach, but produce vomiting. It remained to ascertain whether, in animals incapable of vomiting, salts of copper would act as poison. At a recent meeting of the Société de Biologie, M. Gallipe described some experiments on the subject. He had given several rabbits copper with their food. One of these animals received daily, for six months, two grammes of acetate of copper. At the end of this period, the rabbit showed considerable fattening. Its liver weighed 70 grammes, and contained 13 centigrammes of copper. Further, this rabbit was eaten by the experimenters, who were no way incommoded thereby. This is one fact more (says *La Nature*) in favour of the so-called rehabilitation of copper.

LOCALISATION OF ARSENIC IN THE BRAIN.—Experiments have recently been made on guinea pigs by M. De Poncy and Livon (*Comptes Rendus*), with reference to the localisation of arsenic in the brain, when arsenious acid was given in small doses daily with the food. They found that phosphoric acid increased considerably in the urine, and it can only have come (the authors point out) from an elimination by substitution, not from a pathological state of the animal, for in cerebral affections, rather a diminution than an increase of phosphoric acid in the urine has been observed. The arsenic, then, seems to replace the phosphorus of phosphoglyceric acid in lecithine, producing arsenioglyceric acid. The authors are seeking to isolate this new base.

NOTES

PROF. CHRYSTAL of St. Andrews (formerly of Peterhouse, Cambridge) has been appointed to the Chair of Mathematics in Edinburgh University. He was Second Wrangler and Second Smith's Prizeman in 1875, and is already known to science by his experimental researches on Ohm's Law (made in the Cavendish Laboratory) and by the very excellent article "Electricity" in the new edition of the *Encyclopædia Britannica*. Among the eleven candidates for the chair there were four Senior Wranglers. Thus the Chair of Mathematics in St. Andrews is now vacant; and it has just been announced that Prof. Blackburn has requested the University Court of Glasgow to sanction his retirement from the Chair of Mathematics there. As Prof. Fuller of Aberdeen resigned last year only, the whole of the Mathematical Chairs in Scotland have been vacant within one year.

AT the half-yearly general meeting of the Scottish Meteorological Society, held on Monday, July 21, papers were read on "The Cold Weather since November, compared with Periods of Protracted Cold in Scotland from 1764," by Alexander Buchan; on "The Great Plague of London in Relation to Weather," by Dr. Arthur Mitchell; and on "Ground Swells observed in Scotland since 1868," by Alexander Buchan. With reference to the proposal of General Myer to publish maps exhibiting the simultaneous monthly means in meteorology of the whole of the northern hemisphere, intimated in NATURE, vol. xx. p. 275, the Scottish Meteorologists state, in their Report to the meeting, their conviction "that this truly cosmopolitan work, which the United States alone are in a position to undertake, thanks to the enterprise and liberality of their Government, will bring before us, month by month, the general circulation of the earth's atmosphere, and raise at least, if not satisfy, many inquiries lying at the very root of meteorology, and intimately affecting those atmospheric changes which meteorologists hitherto have been recording."

WE have already referred to the valuable "Bibliographical Contributions" issued by the library of Harvard University and edited by Mr. Justin Winsor, the librarian. One of the most scientifically important of these is a list of apparatus available for scientific researches involving accurate measurements, prepared by means of answers to a circular sent out by Professors Wolcott Gibbs, E. C. Pickering, and Trowbridge, of Harvard. This circular speaks of the cost of the apparatus required for exact quantitative determinations in the various branches of

physics, as always having been a serious obstacle to the prosecution of investigations requiring a high degree of precision. It asks, therefore, from the various institutions addressed, a list of such apparatus of this kind as they possess, and which they are willing to place, under certain restrictions, at the disposal of any properly qualified persons for the purpose of investigation. The principal scientific institutions of the State have responded, and the lists they give convey a highly favourable idea of the completeness and high quality of the apparatus of precision with which American laboratories are furnished. Among the institutions thus prepared to place their equipments at the service of science are the United States Coast Survey, the Academy of Arts and Sciences, the various scientific departments of Harvard University, the Stevens Institute of Technology, Massachusetts Institute of Technology, Columbia College, New York, and the Johns Hopkins University, which, though the youngest of these institutions, has an admirably complete scientific equipment. Mr. Winsor is to be congratulated on the wide extension he has given to the significance of the term bibliography, and on the service he is doing science in the United States.

FROM the *Chemical News* we learn that a newly-discovered metal, Norwegium, has been detected and isolated by Dr. Tellef Dahll in a sample of copper-nickel from Kragerö, in Skjærgaarden. The colour of the pure metal is white, with a slight brownish cast. When polished it has a perfectly metallic lustre, but after a time it becomes covered with a thin film of oxide. It can be flattened out in an agate mortar, and in hardness it resembles copper. The melting-point is 350° C., and the specific gravity 9·441. Its equivalent appears to be 145·9. Only one oxide, NgO, has been obtained. With sulphuretted hydrogen it gives a brown sulphide, even in strongly acid hydrochloric solutions, which redissolves in ammonium sulphide. With a slight addition of potassium ferrocyanide it gives a brown, but with larger proportions a green precipitate. The sulphuric solution is turned brown on the addition of zinc, and the metal is deposited in a pulverulent state. The solutions of this metal are blue, but become greenish on dilution.

THE cranium of Descartes is often adduced as an exception to the general rule that a great mind requires a large brain. This statement seems to have rested on no exact measurement, and Dr. Le Bon resolved recently to test its accuracy. The result is that he finds the cubic capacity of Descartes' skull to be 1,700 centimetres, or 150 centimetres above the mean of Parisian crania of the present time. At the same time Dr. Bordier has recently found the average capacity of the skulls of thirty-six guillotined murderers to be 1,547·91 c.c., the largest reaching the high figure of 2,076 c.c.

THE Paris International Exhibition of Sciences applied to Industry will be opened to-day. It is divided into eleven groups. The first group contains prehistoric subjects, anthropology, sociology, and education. The eight following groups are respectively applications of physics, of chemistry, of mechanics, mechanics applied to locomotion, application of the natural sciences, mathematical sciences, the applications of geology, books, and manuscripts. The tenth group will contain (1) The artificial reproduction of a glacier with an interior grotto, which will show the several geological strata containing characteristic fossils. (2) The reproduction on a large scale of a civilised house of the nineteenth century, a hut of savages, and a prehistoric habitation. (3) A map of Europe in the tertiary period executed in relief. (4) A dioramatic view of the actual site of Paris during that period. (5) Another dioramatic view just before the time when man made his first appearance on the earth. Group 11 will be devoted to a retrospective exhibition of objects belonging to art and industry. The most notable innovation will be the creation of a commission of scientific inquiry to obtain information from exhibitors, which will be published with a commentary from the commission. The commission of patronage is composed of MM. Carnot, Dr. Henry Lionville, Henry Martin, Charles Blanc, &c. The works are progressing with great activity, and are lighted by the electric light on the Jablochkoff system, which will illuminate the Exhibition at night.

WE are requested to state that at the Sheffield meeting of the British Association there will be an important exhibition of scientific apparatus and specimens, both in the temporary museum and at one of the *soirées*. Inventors and others who may have objects of interest to exhibit are desired to at once communicate with the local secretaries, Sheffield, as this will be an unusually favourable opportunity for bringing their discoveries before the scientific world.

AT the recent meeting, already referred to by us, of ladies and gentlemen interested in Japanese art, literature, folk-lore, &c., at the rooms of the Royal Asiatic Society, a committee was appointed to consider the best mode of giving effect to that object in communication with the Council of the Royal Asiatic Society. Among the Committee are—Sir Rutherford Alcock, K.C.B., Sir Charles Wentworth Dilke, Bart., M.P., Prof. Robert K. Douglas, Major Gen. A. Lane Fox, F.R.S., E. J. Reed, C.B., M.P., F.R.S., E. B. Tylor, LL.D., F.R.S. At a meeting of this Committee on the 11th inst. it was resolved that for the objects in view a Society should be formed, to be called the "Nipon (Japan) Institute," to consist of members subscribing a sum of 10*s.* per annum, and that the permission of the Council of the Royal Asiatic Society be asked to allow such Society to hold meetings at their rooms, 22, Albemarle Street. It was also resolved that a Committee be appointed to act, with Mr. Pfoundes as Secretary, in the organisation of such Society, and to conduct the necessary correspondence. On this Committee, besides others, are those whose names are given above. It is proposed that the institution shall consist of a Central Institution; a President; Council; General Committee; Councils of Division, *e.g.*, Antiquities, Art, Anthropology, Folk-lore, Geography, History, Language, Literature, &c., and Committees of Sections; a Chief Branch in Tokio, Japan; Branches in Japan, China, India, Australia and other Colonies, United States and other parts of America, Continent of Europe, Provincial Towns of Great Britain, &c.; in Correspondence with Central Institution; Corresponding Members where no branches exist. The Society is to encourage and reply to inquiry; to solicit literary and scientific ladies and gentlemen to suggest subjects for inquiry and collection of material; to arrange lectures, *soirées*, *conversaziones*, exhibitions, social reunions, and parties to view collections, &c.; and otherwise keep alive the public interest in Japanese topics, &c.

THE "Naturforschende Gesellschaft" of Halle will celebrate the 100th anniversary of its foundation on the 30th instant.

THE death, on July 5, is announced of Dr. Reiff, of Tübingen, formerly Professor of Philosophy at the University of that city.

A NEW natural history museum, formerly the private collection of Dr. L. W. Schaufuss, has just been opened to the public at Blasewitz, near Dresden. Dr. Schaufuss has for many years been in close personal relations with the Archduke Ludwig Salvator, of Austria, well known by his scientific writings and travels, and the new museum therefore bears the name of its founder's august friend and patron. Besides numerous natural history objects it also contains others of anthropological and ethnological interest.

A CORRESPONDENT asks if there is any flora of Cape Colony published? and if there is any book which would be useful in the practical study of the Cape flora? In reply we may state that three volumes have been published of Harvey and Sonder's "*Flora Capensis*" (Lovell Reeve). We understand Mr. Dyer

is engaged upon a continuation of it, the fourth volume being now in progress. For a general review of the flora see Harvey's "Genera of South African Plants," edited by Hooker (Reeve); Harvey's "*Thesaurus Capensis*" may sometimes be procured secondhand.

A LARGE number of mammalian bones of the diluvian period have lately been obtained from the bone-cave of Vypustek, Moravia (Prof. K. Th. Liebe, *Proceed.* Imp. Acad. Vienna, May 23, 1879), and sent to the Imperial Museum at Vienna. The comparison of these remains with those from the Thuringian caves is important, especially with those from the cave of Lindenthal near Gera, which led Liebe and Nehring to the interesting conclusion that all this region was an extensive barren steppe, without any forest vegetation, at the beginning of the Second Diluvial Period. In the cave of Vypustek are found—*Lynx vulgaris, Felis catus, Canis spelæus, C. familiaris, Vulpes vulgaris, V. lagopus, Gulo borealis, Martes abietinus, Fœtorius putorius, F. erminea, Vesperugo serotinus, Arvicola amphibius, A.*sp., *Lepus variabilis* (*timidus ?*), *Cricetus frumentarius, Myoxus glis*, and *Sciurus vulgaris*. Besides these seventeen species, von Hochstetter found remains of *Elephas primigenius, Rhinoceros tichorhinus, Equus fossilis, Bos priscus, Cervus tarandus, C. elaphus, C. capreolus, C. euryceros* (?), *Capra ibex, Ursus spelæus, Felis spelæa*, and *Hyæna spelæa*; the number of species found in the Vypustek Cave being therefore twenty-nine. The evidence proves that this cave was a den of beasts of prey, long tenanted by families of hyenas and bears, and occasionally visited by lions, lynxes, and wolves; while many side galleries, some opening to day, gave shelter to martens, weasels, and other small carnivores. Some few animals may have been carried into the cave after death by streams and floods; but by far the greater part of the remains are those of tenants of the cave, or of their prey brought in for food. The fauna of this cave indeed bears a decidedly sylvestran character; and it may be admitted that its environs were covered with woods, and had a forest climate, at the time when northern and middle Germany had the features and climate of a steppe. Hence too the mountains and hills of South Bohemia and Moravia may be supposed to have been the centre from which forests advanced gradually in every direction over the great Diluvial Steppe of Europe north of the Alpine chain. Further explorations, to be conducted by the Prehistoric Commission of the Imperial Academy of Vienna, may lead to further interesting facts as to the relative depth and succession of the animal remains in this cave.

GREAT damage to agriculture has been done by swarms of grasshoppers in Hungary, in the Szathmar Comitat. An area of some 600 Hungarian "Joch" is entirely devastated. The local authorities have been compelled to apply to Budapest for military assistance, besides availing themselves of that of the inhabitants of numerous villages in the districts affected by the plague.

ON July 1 a monthly serial, entitled *Der Phonograph*, appeared at Vienna, edited by Wilhelm Stockinger, and having for its object the cultivation and propagation of Faulmann's "phonography."

IN this month's number of the *Mineralogical Magazine* is the history of a remarkable gem, called the "Maxwell-Stuart" topaz, which is undoubtedly the largest cut precious stone known. Its weight is 1,475·9 grains, or 368 carats 3·9 grains; specific gravity, 3·5685. It is perfectly white and very brilliant. It was brought from Ceylon many years ago, and has been for a considerable time, in an uncut state, in the possession of Mr. Maxwell-Stuart, a collector of gems, after whom it takes its name. An idea of its size may be formed by stating that the table is 2½ inches in length. It was cut and polished in London, under the supervision of Mr. Bryce-Wright, the present owner, the operations occupying twenty-eight days.

MR. MORRIS, the well-known botanist in Ceylon, whose endeavours to find a remedy for the disastrous coffee-leaf disease we have before referred to, has established the fact that very favourable results may be obtained from the application by hand of a mixture composed of three parts of lime and one of sulphur.

THE officers of the French Balloon Committee tried several ascents last week, in order to determine the visibility of terrestrial objects at various altitudes.

AT a recent meeting of the French Physical Society M. Bouty described the action of heat on metallised thermometers. The contraction produced at the moment of deposit of the metal is entirely compensated by the difference of the dilatations of the glass and the metallic envelope, at a temperature which is higher the greater the contraction, and the smaller the difference of the dilatations, but independent of the thickness of the deposit. Above this critical temperature traction takes the place of pressure on the bulb; ruptures presently occur at the surface of contact, and the result is permanent deformations, which produce a new displacement of zero. This latter effect is never produced when the critical temperature is not exceeded. A metallised thermometer may be used to measure temperatures, if it have been compared with a typical thermometer, from which it does not differ sensibly unless the metallic deposit be of considerable thickness. When sulphate of copper is electrolysed between two very sensitive thermometers, coated with copper superficially, the thermometer attached to the positive pole is found to be at a temperature superior, the negative thermometer at a temperature inferior, to that of the surrounding liquid. The same phenomenon is observed in electrolysing sulphate of zinc between two thermometers covered with zinc. M. Bouty recalled the fact that when two plates of zinc or of copper are kept at different temperatures in the corresponding sulphate, a current arises, and the warmer metal is the positive pole. There is between the production of these currents and the phenomena studied by M. Bouty a relation of reversibility similar to that which connects Peltier's phenomenon and ordinary thermo-electric currents.

THE electro-magnetic rotation of the plane of polarisation of light in gases has recently been proved and studied variously by Kundt and Röntgen, Bichat and H. Becquerel. The last-named observer, by a superior method, measured the phenomenon especially in ordinary coal gas, while the others demonstrated the rotation in sulphide of carbon vapour, gaseous sulphurous acid, and sulphuretted hydrogen. In a paper to the Vienna Academy, Prof. Lippich, of Prague, describes additional experiments on the subject. He aimed especially at perfecting the optical part of the apparatus, and attained remarkable accuracy. He succeeded in demonstrating the rotation *in air*, using a large coil 0·5 metres long, with 365 m. length of copper wire (nearly 3 mm. thick) in twelve layers. The current was from sixty average Bunsen elements, combined in a battery of thirty double elements. The light-ray was simply sent through the hollow part of the coil. Under these circumstances an unmistakable electro-magnetic rotation was observed, and it was in the direction of the current coursing round the air. The angle of rotation could not have been far from 6 to 10 seconds of arc. (An exact determination was not possible, owing to the provisional arrangement of the optical apparatus.)

THE last number of the *Journal* of the Society of Arts contains two elaborate papers by Mr. A. T. Atchison and Mr. W. H. Penning, giving suggestions for dividing England and Wales into watershed districts, with reference to the National Water Supply.

THE *Sanitary Record* is now appearing in an enlarged form as a monthly, instead of a weekly as hitherto.

THE additions to the Zoological Society's Gardens during the past week include a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, presented by Mr. Robt. F. Clothier; two Ring-tailed Lemurs (*Lemur catta*) from Madagascar, presented by Mr. Hugh McCubbin; a European Bearded Vulture (*Gypaetus barbatus*) from Southern Spain, presented by Lord Lilford, F.Z.S.; three Globose Curassows (*Crax globicera*) from Central America, presented by Major F. Hime; a Lesser Sulphur-crested Cockatoo (*Cacatua tenuirostris*) from Moluccas, presented by Miss Langley; a White-tailed Gnu (*Catoblepas gnu*) from South Africa, two Mule Deer (*Cervus macrotis*) from North America, a Common Ocelot (*Felis pardalis*), a Red and Yellow Macaw (*Ara chloroptera*) from South America, deposited; a Funereal Cockatoo (*Calyptorhynchus funereus*) from New South Wales, four Common Crowned Pigeons (*Goura coronata*) from New Guinea, two Yellow-bellied Parrakeets (*Platycercus flaviventris*) from Tasmania, an American Kestrel (*Tinnunculus sparverius*) from South America, a Smooth Snake (*Coronella lævis*) from Hampshire, purchased.

ON TWO METEORS OBSERVED IN SWEDEN IN 1877 [1]

THE first meteor was observed over a great part of the middle of Sweden from Stockholm, in the east, to Charlottenberg (and Christiania), in the west, and from the neighbourhood of Åreskutan, in the north, to Jönköping, in the south. Accounts of the phenomenon by forty-seven different observers are given. By a comparison of a number of those observations it appears that the meteor was seen nearly simultaneously over the whole of the area where it was visible, on March 18, at 7h. 52·5m. P.M. Greenwich mean time. The phenomenon lasted only a few seconds.

When lines, showing the direction in which the meteor was seen from every separate point of observation to sink under the horizon or in which the last explosion took place, are drawn on the map, most of them meet on the Lake Vener, in the region of Vermlands Näs. The terminal point of the meteor's path was thus clearly situated above this region. Observations from Stockholm, that the meteor disappeared about half way between the moon and the horizon, and from Örebro that it split into fragments by the side of the moon, show that the last explosion took place at a height of 37 to 38 kilometres. Observations from Carlstad and Edsvalla, that the meteor passed through the zenith, and from Mora, that its path was vertical, indicate a projection of its path over Mora and Carlstad, to Vermlands Näs. At first its inclination appears to have been only about 30°, but afterwards it became considerably greater. Besides the final explosion there were three other points of the meteor's path at which it threw out sparks, the first at a very considerable height—*over 200 kilometres*, the second at a height of 100 to 150 kilometres. These figures, for which, however, no great degree of accuracy can be claimed, are deduced from an observation made in the neighbourhood of Örebro. That the continuation of the meteor's path could not be observed from this point was probably caused by the masses of dense cloud which the meteor heaped before it in its path, and which, in the neighbourhood of the place where it fell, almost completely concealed it from view.

As is commonly the case with meteor detonations in general, the sound was propagated with excessive irregularity, violent explosions having been heard in some places, while in others close by the whole phenomenon appeared to proceed without sound.

The circumstance that in the region of Vermlands Näs, at Edsvalla, Carlstad, Kinnekulle, and other places over which the meteor sprang asunder for the last time, no proper fireball was visible, but only a thrice-repeated lightning-like flash, shows that here, too, a part of the meteor's light was intercepted by the dense, cloudy masses which the meteor drove before it. A remarkable observation was made at Skinnskatteberg. There the strongly-luminous meteor projected on the snow-covered ground four or five bands of light with dark intervals, "without there being any object between the meteor and the earth to cast a shadow," the shadow in this case having probably been caused by fragments of cloud in the neighbourhood of the meteor.

[1] By Prof. Nordenskjöld. Abstract of two papers in *Trans.* of the Geological Society of Stockholm, 1878, Nos. 45, 46, and 47.

The diameter of the meteor, as calculated from a number of observations of apparent size, varied from 200 to 2,500 metres. Prof. Nordenskjöld considers it probable that the Vener meteor, in its path through the atmosphere, formed a luminous ball of 400 to 500 metres' diameter.

When the above-described phenomenon took place, the ground in the middle and north of Sweden was still covered with snow, a circumstance favourable for ascertaining whether any solid particles fell from the meteor in question in the form of meteoric dust to the surface of the earth. Prof. Nordenskjöld requested a student, Herr Svenonius, to proceed to the supposed place of fall, and to endeavour, both by his own researches and by inquiries of persons resident in the region, to discover any remains of the meteor. He travelled several times across the region, and employed a large number of people in searching on the ice on Lake Vener. The result was negative, with the exception that Herr Svenonius found on Lake Vener small quantities of a black or dark grey dust, of doubtful origin, which under the microscope appeared to consist of—

1. Small aggregates of cells derived from higher plants and isolated or coupled plant-cells.
2. A black colloid substance, which formed the main mass of the dust.
3. Inorganic particles of dust, which were *isotropical*, and could thereby be easily distinguished from grains of sand, which entered very sparingly into the mixture. The dust scarcely contained any particles that were capable of being attracted by the magnet, whereby it differed completely from the dust collected on the polar ice during the Swedish expedition of 1872-73. From the small quantity of material that could be employed for analysis, no complete chemical examination of the inorganic constituents could be carried out. The principal constituents were silica, 38 per cent., oxide of iron, 34 per cent., alumina, 8 per cent. No trace of cobalt, nickel, or phosphorus could be discovered.

The dust was found in small quantity on the borders of the small pools, which, under the influence of the spring rise of temperature, were formed everywhere on the ice of Lake Vener.

It is probable that this meteor mainly consisted partly of gaseous substances, partly of carbon, so finely divided that it was completely burned during the short path of the meteor in the atmosphere of our globe.

The second meteor was seen on April 29 at 8.37 P.M. Greenwich mean time, over the greater part of Sweden, from a point lying a little to the south-east of Gothenburg to Vittangi in the extreme north. It was also seen over a great part of Finland, and at St. Petersburg and Dorpat. Accounts from no fewer than seventy-three different places are given. The meteor had, when first observed, the appearance of a large star. Its size increased, however, at first slowly, afterwards rapidly, so that it at length gave out a light so bright that the country over which it passed was lighted up as if it had been full day. The light increased in brightness until the meteor exploded about half way between Luleå and Piteå at a height of 35 kilometres. The time that elapsed between the first appearance of the meteor and its explosion did not exceed a minute and a half. The phenomenon, however, did not come to an end then. A part of the meteor appears, after the explosion, to have continued its course, and perhaps may have passed out of the atmosphere. Besides the usual line of sparks which generally marks the path of a meteor for some moments, there occurred in this case along a considerable part of the path a splendid light phenomenon of a red colour, *which, however, was only observed in regions far removed from the place of explosion*. This red appearance lasted from fifteen to thirty minutes. After it ceased the path of the meteor was still marked in the heavens for a long time (upwards of an hour) as a light band of cloud, which first assumed a zigzag form and then gradually disappeared. The whole phenomenon accordingly lasted nearly two hours, and it is probable *that the meteor, or parts of it, both when it first appeared as a star and after the red light ceased, shone not with its own light but with light reflected from the sun*.

The statements as to the time during which the *fire-ball itself* was luminous in the atmosphere differ, varying from some few to ninety seconds. The latter, however, is the only one which has reference to the whole of the time during which the meteor was luminous from its first appearance as a large star to its explosion.

in the region of Luleå. The red light was visible at different places for periods varying from ten to thirty minutes, the light streak of cloud from some minutes to seventy-five, the whole phenomenon being visible from ten to 105 minutes.

At places nearest to the locality of explosion and at some others there was seen only the intensely luminous fire-ball, not the red after-light, probably in part owing to the sky being cloudy, and in part also for the same reason as that which caused the dark central field in the case of the Ställdalen meteor.

The observations reported correspond so closely with the figures calculated on the supposition that the explosion took place *half way between Luleå and Nederkalix at a height of* 35 *kilometres above the surface of the earth*, that this point of the meteor's path may be considered as determined with considerable accuracy.

All observers agree in this, that the red pillar of fire which immediately after the explosion was seen at Upsala, Stockholm, Fredrikshamn, St. Petersburg, &c., had at first the same direction as the meteor's spark-bestrewn path, but that the position of the fire-pillar towards the close of the phenomenon underwent change by its spreading out to a height in the atmosphere which in the north of the Gulf of Bothnia was about three times as great as that of the fire-ball proper.

The tangent of the meteor's path at the place of fall had an inclination to the horizon of about 25°. The radiation point was situated somewhere in the constellation Orion. The meteor appears to have been first seen at a height at which it was beyond the earth's shadow, and illuminated by the sun. At first it had the appearance of a bright star, but afterwards increased rapidly in diameter till its apparent size was equal to that of the sun or moon. From a comparison of numerous observation it appears that the meteor's luminous nucleus had a diameter of 1,000 metres.

The Luleå meteor is interesting for the splendid light-phenomenon visible after its explosion, and particularly for the long time it remained in the atmosphere without much change of place.

This light began immediately before the meteor exploded in the region of Luleå, but it could not have been caused by combustible substances thrown off in consequence of the explosion, as in that case the red light ought to have spread itself from the place of explosion about equally in all directions, and afterwards have sunk down rapidly and gone out. Instead, this light was extended in the direction of the meteor's path, and it remained in the sky for more than an hour. An approximate idea of its size and height in the atmosphere is given by observations at Upsala and Fredrikshamn:—

	Breadth of the red luminous pillar.	Approximate height of the point.
Upsala (2)	6 kilom.	125 kilom.
Fredrikshamn ...	12 ,,	150 ,,

The appearance of this light varied much. At some places it resembled a pillar of equal breadth ("like a beam"), at others it appeared as a red spot, from which a pillar of the same colour descended to the horizon but disappeared sooner; at others, again, luminous rings were observed. After the light itself disappeared, its position in the sky was marked for a long time by numbers of "wool-like" clouds.

Several observers remark that the red fire-pillar in question, during the time that it remained visible in the sky, slowly assumed a more vertical position, and then took the form of a 7 or a reversed S.

The Luleå meteor besides, like most other meteors, left behind it for some moments a white luminous streak of fire in that part of the sky through which it passed. This streak of fire clearly arose from constituent parts of the fireball proper which had been loosened by the resistance of the air, and remained behind.

The red light, on the other hand, appears to have had a different origin. It could not have consisted of small particles left behind in the uppermost strata of the atmosphere, for they would speedily have fallen down. The light rather appears to have originated from new combustible or luminous material which followed the nucleus of the meteor, and for the space of half an hour entered the atmosphere at nearly the same place. The Luleå meteor was thus a true cometoid.

It appears that the attraction of the earth and the retardation caused by the resistance of the air gave the path of the dust, causing the red light, a more parabolic form than that of the meteor's nucleus, for a number of observers state that the red pillar gradually raised itself from the slanting position of the path of the meteor towards the vertical line. The direction of the meteor's train, as in the case of true comets, did not lie quite in the path of the meteor. The foot of the luminous pillar was observed above Avasaxa at a height of about 100 kilometres when the nucleus exploded north of Luleå. After the disappearance of the red light there remained white and woolly clouds, resembling light clouds illuminated by the sun. These may have arisen from parts of the meteor which were directly illuminated by the sun, and thus became visible when the stronger light, caused by direct combustion, ceased. On April 29, in the latitude of Avasaxa, bodies at a greater height from the surface of the earth than 76 kilometres are beyond the shadow of the earth even at midnight.

The meteor's light was at first white, then for a long time of the same shade of red as the dawn, and near the close of the phenomenon again white. The light probably arose from the combustion of carbon and carburetted hydrogen, the products of combustion, steam, carbonic acid, &c., absorbing part of the rays of light, and giving the nucleus a reddish tinge. Towards the close the gaseous envelope was dispersed, and the red colour ceased a long while before the meteor finally disappeared. Search was made for any meteorites or meteoric dust that might have fallen, but none were found, although stones were seen to fall to the ground "like rain" by two Lapp girls near Jockmock, and a Lapp reindeer-herd on the mountain Sarvikobbo saw the "stone-swarm" in question disappear in the forest *below* him.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 6.—In view of the considerable discrepancy between observation and theory with regard to the propagation of electricity, Herr Lorenz has been led to make fresh experiments (here described). In one method the telephone was used; the other was a modification of Feddersen's jar-discharge method. Herr Lorenz shows that, in the case of iron telegraph lines, the magnetism of the iron must be considered. The electro-dynamic constant of unit length of an overland telegraph wire is expressed by $C = 2 \log. \frac{2h}{a} + 2\pi k$, where h denotes the height above the ground, a the radius of the wire, and k the function of magnetisation. For unmagnetic wires, the latter member falls away. Applying the formula to Fizeau and Gonnelle's experiments, and putting the function of magnetisation of the iron wire = 10, we get the velocity 126000 km., while that observed was 101710 km. The difference is much less than by the ordinary reckoning, and may be attributed, the author thinks, to faults of insulation.—Studying the generation of the currents of a Gramme machine with regard to time and resistance, Herr Herwig finds, *inter alia*, that at the commencement a greater manifestation of force is obtained with greater resistances; but in later stages of development of the current, the force increases more for smaller resistances. The slow development of current with great resistances is shown by the fact that with 13·4 Siemens' units, the full force possible was not reached in four seconds.—Prof. Colley concludes from experiment, that the "polarisation of electrodes" in electrolytes is not to be attributed to dielectric polarisation of the latter, but deserves the name just given. It is not denied, however, that the dielectric polarisation may exist, being completely masked by the other.—Herr Settegaast makes some contributions to quantitative spectral analysis; his paper treating (1) of distribution of a base between chromic acid and other acids; (2) of quantitative mode of determination of nitric acid, and (3) of determination of phosphoric acid.—Among the remaining subjects handled, we note the angle of polarisation of fuchsin (Glan), application of the method of dimensions to proof of physical propositions (Neesen), and the heat-conduction of liquids with reference to currents arising from differences of temperature (Oberbeck).

THE *Quarterly Journal of Microscopical Science*, July, contains:—Notes on some of the reticularian rhizopoda of the *Challenger* expedition, by H. B. Brady, F.R.S., with a plate. In this second memoir several new and most interesting forms are described and figured. The author mentions that he has failed to detect in fresh specimens of *Dactylopora eruca*, P. & J., the structures figured by M. Munier-Chalmas, which figures happen to be reproduced in this number of the Journal, as part of the minutes of the Dublin Microscopical Club.—On the morphology of the vertebrate olfactory organ, by A. M. Marshall, M.A., with two plates.—On the brain of *Blatta orientalis*, by E. T. Newton, with two plates.—On the microphytes which have been found in the blood and their relation to disease, by Dr. T. R. Lewis, with

a plate.—Observations on the glandular epithelium and division of nuclei in the skin of the newt, by Dr. Klein, with a plate.—On the early development of the Lacertilia, with observations on the nature and relations of the primitive streak, by F. M. Balfour, M.A., with a plate.—On certain points in the anatomy of *Peripatus capensis*, by F. M. Balfour, M.A.—Notes and Memoranda.—Proceedings of the Dublin Microscopical club from November 21, 1878, to March 20, 1879.

THE *Journal of Anatomy and Physiology, Normal and Pathological*, July, contains:—On supernumerary nipples and mammæ, with an account of 65 instances observed by Dr. J. M. Bruce, with a plate.—On the origin and composition of the bodies found in compound ganglia, by Dr. G. T. Beatson.—On the physiology of the Turkish bath, being an inquiry into the effects of hot dry air upon man, by Dr. W. J. Fleming.—On the form and structure of the teeth of *Mesoplodon layardii* and *M. sowerbyii*, by Prof. Dr. Turner.—On the element of symbolic correlation in expression, by Prof. Dr. Cleland.—On an intra-thoracic lymphoid tumour, by Dr. R. H. Clay.—On inequality in length of the lower limbs, by Dr. J. G. Garson.—On a large subarachnoid cyst involving the greater part of the parietal lobe of the brain, by Dr. D. J. Cunningham.—On the process of healing, by Dr. D. J. Hamilton, with a plate.—On the dentition of *Bettongia penicillatus*, Gray, by George Leslie.—On a new theory of contraction of striated muscle, and demonstration of the composition of the broad dark bands, by Dr. D. Newman, with two plates.—Note of a case of articulation between two ribs, by Dr. J. H. Scott, with a note by Prof. Dr. Turner.—Additional note on the organ of Bojanus, by M. M. Hartog, M.A.—On a two-headed sartorius, by G. S. Brock.—Note on ethidene, by Prof. Dr. M'Kendrick.—Notice of Kölliker's "Developmental History of Men and the Higher Animals," by F. M. Balfour.

Zeitschrift für wissenschaftliche Zoologie, Bd. xxxii. Heft iii., contains:—Studies among the sponges, by Prof. Elias Metschnikoff, of Odessa, containing notes on the development of *Halisarca dujardinii*, on the anatomy of Ascetta, on the history of development in the calcareous sponges, on the inception of nourishment in sponges, and concluding with some general remarks on the group. Four folding plates illustrate this memoir.—On the power possessed by different mammals of holding fast to and moving upwards by means of atmospheric pressure on smooth and more or less perpendicular surfaces, by Dr. O. Mohnike.—Contributions to our knowledge of the organs of generation in the free living copepoda, by Dr. A. Gruber, with five plates.—Researches on the minute structure of the intestinal canal in *Emys europæa*, by Dr. J. Machate, with a plate.—On a new species of infusorian (*Tintinnus semiciliatus*), by Dr. V. Sterki, with figures.—On the final alterations in Meckel's cartilage, by Dr. B. Baumüller, with two plates.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, July 14.—M. Daubrée in the chair.—The following papers were read:—Addition to my memoir on the principle of least action, by M. Serret.—On the direct combination of cyanogen with hydrogen and the metals, by M. Berthelot. Cyanogen and hydrogen, pure and dry, mixed in equal volumes, and sent through a narrow glass tube heated to 500° to 550°, give some sign of combination; but the reaction is more complete when the mixture is heated several hours to the same temperature in a sealed tube of hard glass; this is afterwards opened over mercury. The union of cyanogen with some metals was found also to be merely a question of time and temperature. The substances were heated together in a sealed tube. Silver and mercury did not combine with cyanogen at any temperature. The analogies of cyanogen with the halogen substances are extended in this inquiry, beyond formulæ, to methods of direct synthesis.—On the organo-metallic radicals of tin: stannbutyls and stannamyls, by MM. Cahours and Demarçay.—On an application of the theory of elliptic functions, by M. Picard.—Researches on the effects of the rheostatic machine, by M. Planté. Using a machine of 80 condensers charged by his secondary battery of 800 couples, he obtains noisy sparks more than 0·12 m. long, and if they are produced above an insulating surface sprinkled with flowers of sulphur, they may even attain 0·15 m., and leave a sinuous furrow. When short of their maximum length they often form closed branches like *anastomoses*; also, on the sprinkled surface, *arborescences*, which appear after removing the excess of sulphur by a few light taps. This, M. Planté thinks, may explain the plant-like impressions sometimes found on the bodies of persons struck by lightning. But little dynamic electricity is required for these and other static effects described (that from 3 or 4 Daniell elements). By associating all the condensers in surface, and adding a small special rotating commutator, static effects of *quantity* are had, different from those of *tension*. By mechanical force of successive sparks M. Planté elevates water.—On the treatment by submersion of vines attacked by phylloxera, by M. Faucon. Some of the insects always survive.—On the phylloxera in the Côte d'Or, by M. Viallane.—On the treatment of anthracnose; observations of M. Puel, by M. Portes. The efficacy of lime is demonstrated.—Observations at Marseilles Observatory, by M. Stephan.—On a definite integral, by M. Callandreau.—On the integration of equations with partial derivatives of orders superior to the first, by M. Pellet.—Minimum of dispersion of prisms; achromatism of two lenses of the same substance, by M. Thollon. Two lenses of the same substance, traversed, the one at the minimum of dispersion, the other at the minimum of deviation, by a luminous beam, may at once deflect and achromatise the light. Hence a system of lenses of the same matter may be made, having one focus and at the same time being achromatic.—On the vapour of bisulphydrate of ammonia, by M. Isambert.—On the dissolution of carbonic oxide in acid protochloride of copper, by M. Hammerl. A thermo-chemical investigation.—On the transformation of tartaric acid into glyceric and pyruvic acids, by M. Bouchardat.—On the isomerism of borneol, by M. De Montgolfier.—On bichlorhydrate of turpentine, by the same.—On some derivatives of indigotine, by M. Giraud.—Comparison of effects of inhalations of chloroform and ether, in anæsthetic and in toxical dose, on the heart and the respiration; applications, by M. Arloing. In the first phase attention should be given both to the heart and the respiration, whether chloroform or ether be used; in the second, the heart must be watched, and especially in the case of chloroform; in the third, the respiration. Chloroform should be preferred to ether, where the operation may be long, as the *denouement* of intoxication by ether is more sudden.—Causes of death from intravenous injection of milk and sugar, by MM. Moutard-Martin and Richet. Death from injection of a great quantity of milk is the result of bulbar anæmia, which produces phenomena of excitation.—On the reproduction of Amblystomas at the Museum of Natural History, by M. Vaillant.—Comparative anatomy of the Hirudineæ; organisation of the *Batracobdella latasti*, C. Vig., by M. Vignier.

CONTENTS

THURSDAY, JULY 31, 1879

THE NEW NATURAL HISTORY MUSEUM

NOTWITHSTANDING the delay caused by discussions on the Zulu campaign and the Army Discipline Bill, the Civil Service Estimates must shortly come before the House of Commons, and an opportunity will be given for obtaining from the Government some explanation of the course they propose to adopt with regard to the administration of the New Museum of Natural History. As will be seen by the memorial, of which we gave a copy some weeks ago, the Council of the British Association for the Advancement of Science, in accordance with the resolution adopted by the Association at the Dublin meeting, have strongly urged the pressing importance of this question upon the Government. Naturalists, we believe, are one and all of the same mind on this subject, but owing to the many important political questions of the day, and to the general ignorance of, or we may perhaps say, indifference to, the true wants of science, find it very difficult to get their wishes attended to. Their general opinion upon the British Museum question may, we believe, be shortly stated as follows.

The dominant idea, as we all know, of the Founders of the British Museum was the library. The collections of natural history and antiquities which have been added to it during the past fifty years have always been regarded as entirely subordinate, and not-to-be-too-much-encouraged parts of the general scheme. The executive officer of the whole institution has always been the "principal librarian," trained up in the book department, and having his great aim and object to make that department as perfect as possible. Some years ago, in obedience to pressure from without, an eminent naturalist was made "superintendent" of the four sections of the museum which relate to natural history, namely, zoology, botany, geology, and mineralogy, but care was taken to give him no real power, and his authority, we believe, has remained completely nominal up to the present day. The "superintendent of the natural history departments" has never been allowed to interfere in any way with the important functions of the principal librarian, in whom the administrative power of the whole of the Museum is vested. Now fifty years ago, in the infancy of natural history in this country, such an arrangement as this might have answered very well, but with the gigantic strides that science has made of late years, it is not likely that naturalists will be content to allow the great National Museum of the country to continue to be governed by an individual of no scientific attainments whatever, and to be entirely subordinated to the predominant interests of the Public Library. When the Royal Commission on Science was appointed in 1872, and the question of the British Museum came before it, the grievances of the naturalists found vent, and the systematic injustice with which this department of the Museum had always been treated was fully exposed. After taking full evidence on this subject, the Royal Commission came to the conclusion that the objections raised to the present system of government of the natural history collections were "well founded," and were "unable to discover that the system is attended by any compensating advantages." The Royal Commission recommended consequently that the opportunity should be taken of the proposed removal of these collections into the new building at South Kensington, to separate them at the same time entirely from the control of the trustees and to place them under the rule of a director, who should be responsible to one of the Ministers of State.

It might have been well supposed that such a recommendation, coming as it did from a Royal Commission composed of some of the leading scientific authorities of the country, and backed by the universal opinion of naturalists, would not have been ignored. But such is the apathy displayed by our Government, when questions merely of scientific interest are at stake, that the recommendation appears to have been entirely overlooked. At the fag end of last session the trustees of the British Museum were permitted to pass an act enabling them to move the natural history collections to South Kensington without making any changes whatever in the mode of their administration, and not a single member of the Legislature appears to have raised his voice against this summary mode of dealing with the question.

Unless something can be done to upset the conclusion thus arrived at, it is obvious that the evils so loudly complained of during the stay of the natural history collections in Bloomsbury will accompany them in their migration to South Kensington. The library at Bloomsbury will continue to be regarded as the main business of the fifty trustees, and the natural history at South Kensington will, as of old, be starved in order to feed the wants of the more favoured institution. Besides this, many absurd laws and antiquated regulations exist in the British Museum which it would be highly inexpedient to introduce into a new institution, and which can only be got rid of by a complete change of the ruling powers.

It is said that the trustees of the British Museum, having had the memorial of the British Association pressed upon their attention by the Treasury, are prepared to make certain concessions as regards the management of the New Museum at South Kensington. But in the face of the strong recommendations of the Royal Commission we do not believe that any arrangement of this character will be deemed satisfactory.

In fact, the only hope of good government for the new Museum of Natural History lies in its entire separation from the unnatural foster-sister with which it has been hitherto reared. Every man of science will, we think, agree with the Duke of Devonshire's Commission in considering that natural history has now full claims to a separate maintenance, and will render thanks to the Council of the British Association for their efforts to impress the importance of the recommendations of that Commission upon Her Majesty's Government.

BRAIN AND MIND

The Relations of Brain and Mind. By Henry Calderwood, LL.D., Professor of Moral Philosophy in the University of Edinburgh. (London: Macmillan and Co., 1879.)

THE object of this work, Prof. Calderwood says in his preface, "is to ascertain what theory of mental life is warranted on strictly scientific evidence."

"The order followed is to consider, *first*, the latest

results of anatomical and physiological research as to the structure and functions of the brain; *second*, the facts in human life unaccounted for by anatomical and physiological science, and requiring to be assigned to a higher nature."

In these words our author indicates not merely his method, but the conclusions as to the relations of mind and brain to which his investigations have led him.

The first six chapters deal with the anatomy and physiology of the brain, both human and comparative. In these and also in other parts of the work Prof. Calderwood exhibits an extensive acquaintance with the facts of cerebral anatomy, physiology, and pathology, worthy of any technical neurologist, and which reflects especial credit on an author hitherto identified with purely speculative philosophy.

As the result of his study of the comparative anatomy and physiology of the brain, he reaches the position that the brains most elaborate in convolution are indicative mainly of the most highly developed muscular system. The development of the brain is, however, no test of "intelligence." This, he contends, is most strikingly brought out by a comparison of the brain of man and the ape. "The ape, with a brain modelled like man's, and weighing 15 to 20 oz., shows himself active, powerful, and able to assail any adversary; man, with a brain better developed, and 10 to 15 oz. heavier, is tottering, feeble, and idiotic, unable to defend himself from even a weak assailant. If configuration and structure of brain afford a measure of intelligence, our poor idiotic fellow-man should be so much clearer in intellect and decided in action than the highest specimens of apes. But it is not so" (p. 161).

The comparison here instituted is a very fallacious one. The exact formula for the relationship between brain development and intelligence in different animals has yet to be found. That it is not a mere matter of size is generally admitted. But that the relationship is thorough-going is proved by the very fact here alluded to by Prof. Calderwood, that below a certain standard of development idiocy is the invariable result. The comparison should not be between a microcephalic idiot and a normal ape, but between a normal ape and a microcephalic one. The microcephalic ape would certainly be idiotic.

At the close of his review of the facts of cerebral anatomy and physiology Prof. Calderwood says: "At this stage it seems our only possible conclusion that anatomical and physiological investigation as to brain and nerve, so far as they have yet been carried, afford no explanation of our most ordinary intellectual exercises" (p. 216).

He quotes with approval Prof. Tyndall's words that "the passage from the physics of the brain to the corresponding facts of consciousness is unthinkable," &c. (p. 212); but not content to accept the two as correlated facts insusceptible of further simplification, he endeavours to prove by "personal experience" that mind is altogether distinct from brain, and of a higher and immaterial nature.

"That we discriminate between sensations and perceptions, and consequently form conceptions of things, are facts towards the explanation of which all that is known concerning the action of nerve-fibres and cellular substance contributes nothing" (p. 224). "The known laws of brain action do not provide for this; they imply that the nerve system is not equal to such work" (p. 221).

In his chapter on "Experience as connected with Motor Activity" (Chapter VIII.) we find the following account of the nature of volition:—"What we mean by volition or exercise of will-power is best shown, in the first instance, by marking its contrast with nerve-action. It is not that which moves the muscles, but that which moves the nerve-cells to act upon the muscles. It is not that which moves the limbs, but that which determines that they shall be moved. In its lower and simpler aspect this may be illustrated by reference to sensory activity. A falling stick touches the hand, or a neighbour jostles the elbow. By contact with some external body, an impulse is given to the sensory nerve which is transmitted to the sensory cells. Let us now turn to motor activity. In so far as the originating power *acts upon* the motor apparatus, its action is, in a sense, analogous to that which produces a tactile impression—it operates as an external power, that is, *external* to the apparatus. Or, to take a form of expression more familiar, there comes from an inner sphere, from the region of personal experience, an impulse which acts upon the motor cell, and throws it into activity. That which acts upon the motor cells is as certainly external to the system as is the object which comes into contact with the sensory system. But in the case of voluntary muscular activity, that which operates acts directly on the cell. And what is not reflex, as not being the product of movement of the sensory nerve, must be accounted for by energy from some other quarter, that is, from a sphere external to the nerve system, though within the nature of the person" (p. 247).

Such being the standpoint assumed by Prof. Calderwood in reference to the simplest forms of mental manifestation, it is unnecessary to follow him in his analysis of the higher mental operations.

He advocates *essentially* the so-called "clavier" theory, that the mind is something of a higher nature and distinct from brain, which plays on brain as on a musical instrument. If the brain is diseased, mental manifestations will be limited or inharmonious, but the defect is purely in the instrument, and not in the performer.

Prof. Calderwood admits that the brain is the organ of the mind; that "a pure independence of mind is not known in our history" (p. 314); that defective development of the brain and idiocy invariably go together; that diseases of the brain are associated with mental derangement (Chapter XIII., "Brain Disorders") and deficiencies (Chapter X., "Use of Speech"); that mind has a powerful influence on body, and that mental work implies physiological waste (Chapter XI., "Action and Reaction of Body and Mind"); and yet, notwithstanding the thoroughgoing correlation between mind and brain which these and similar facts demonstrate, he professes by the aid of personal experience to prove the existence of something distinct from and independent of the conditions of its manifestation. This process reminds one very much of an attempt to lift oneself by the hair of the head, or raise the chair on which one sits. Prof. Calderwood cannot divest himself of his brain by personal experience, nor can he give us any evidence of personal experience without brain.

He acknowledges that "however carefully we study consciousness, we do not thereby attain to any knowledge of the nerve system," and that "only by the slow and

laborious methods of anatomical and physiological research has the human race become aware of the physical conditions of sensory impressions and motor activity" (p. 212).

So far, therefore, as personal experience is concerned, Prof. Calderwood might have equally well relied on it for asserting that sensation and voluntary motion are independent of sensory and motor nerve structures, as for his assertion that mental operations are distinct from the action of brain.

That we are in ignorance of the physical processes underlying many special psychical manifestations may be admitted without invalidating the general fact of their correlation, otherwise clearly established. But to make ignorance on the one side the basis of very positive statements on the other, is to say the least extremely rash. We may not know how or under what collocations of nerve cells and nerve structures subjectivity becomes apparent; but for Prof. Calderwood to exclude it in his definition of the properties and modes of activity of nerves and nerve-centres, and then to argue that personal experience demonstrates it to be something beyond and above, is to beg the whole question.

He very ingenuously estimates the true value of such an argument in a passage, in which he says, "the insufficiency of brain and nerve to perform such work *is really involved in the statement of the laws of brain action and the functions identified as belonging to fibres and cells*" (p. 1. 122, ital. ours). It would be more logical to reconsider and amend the definition.

Prof. Calderwood's endeavour to prove by scientific evidence the distinct nature and independence of mind, is to attempt the impossible. The utmost that scientific evidence is able to accomplish is to show that cerebral activity and the facts of consciousness are correlated facts insusceptible of further simplification and incapable of being expressed in terms of the other.

Whether we adopt the hypothesis of a duality or a dual unity, is a question of faith, not of scientific demonstration. Science can only deal with the knowable.

Considering the very decided stand Prof. Calderwood has taken on the dual theory in the light of the latest researches in cerebral physiology and pathology, it was not unreasonable to expect some new contribution towards the elucidation of the vexed question as to how the immaterial mind can act and be reacted on by the material body. As to whether they are attuned on the pre-established harmony principle or otherwise, Prof. Calderwood gives us no information. On the whole, perhaps, he has in this exercised a wise discretion. But whatever theory as to the intimate nature of mind and brain may be adopted, the correlationship between the psychical and the physical must be accepted, not merely in a general sense, but as regards each individual manifestation. Any work will be gladly welcomed, and will do great service, which serves to throw further light on the relations between psychical phenomena and their anatomical and physiological substrata. Prof. Calderwood's work does not help us in this respect:—rather the reverse. While, as regards the facts of brain on the one hand, and the facts of mind on the other, it contains much that is worthy of praise, as regards their relations it is eminently unsatisfactory.

D. FERRIER

SOUTH-INDIAN PALÆOGRAPHY

Elements of South-Indian Palæography from the Fourth to the Seventeenth Century, A.D. By A. C. Burnell. Second Enlarged and Improved Edition. (London: Trübner and Co., 1878.)

A WORK like that before us is one of those which make us feel proud of our Indian civil servants. Dr. Burnell has made a name for himself in a field of research peculiarly his own, and the appearance of a second edition of his important work on South-Indian Palæography is a matter of congratulation for science. Apart from the historical and linguistic value of the numerous inscriptions here copied and explained, the light thrown by their decipherment upon an obscure chapter in the history of writing is so important that I shall make no excuse for confining myself to this side of Dr. Burnell's labours, the more especially as this is the side to which he has himself devoted the larger part of his book.

Two questions are brought before us at its outset—the date of the introduction of writing into India and the origin of the South-Indian alphabets. The two questions, indeed, hang very closely together, and the one cannot be completely decided without the help of the other. The earliest examples of writing yet discovered in India are the edicts of Aṣoka, the Constantine of Buddhism, about 250 B.C. They are written in two different alphabets, and the irregularities they present have been supposed to show that writing was still a recent art. The alphabet of the northern inscriptions, which may be termed the North Aṣoka alphabet, has been proved by Mr. Thomas to have been derived from an Aramaic original, and consequently to have been introduced by Semitic traders from the Persian Gulf. Dr. Burnell claims a similar origin for the South Aṣoka alphabet, as well as for a third alphabet used only in Southern India, and known as the Vaṯṯeḻuttu or Old Tamil. Of this Dr. Burnell holds that it "is apparently not derived from nor the source of the Southern Aṣoka alphabet, though in some respects very near to it."

These opinions of Dr. Burnell have met with a vigorous opponent in Mr. Thomas, who maintains that both the southern alphabets were of Dravidian origin, the Sanskrit alphabet itself being an adaptation of some pre-existing Dravidian one. But it will be difficult to resist the force of Dr. Burnell's arguments based upon the earliest forms of the South Indian characters and their likeness to corresponding characters in the Aramaic alphabets of the fourth and third centuries B.C. As he justly observes: "perhaps the most important proof of the Semitic origin of the two South Indian alphabets is the imperfect system of marking the vowels which is common to them both. They have, like the Semitic alphabets, initial characters for them, but in the middle of words these letters are marked by mere additions to the preceding consonant."

If we once admit with Dr. Burnell that the South Indian alphabets have the same Phœnician origin as most of the other alphabets of the world, we must go further with him and derive them "from an Aramaic character used in Persia or rather in Babylonia." The progress of palæography has made it impossible to derive

them directly from Phœnicia, as Benfey wished to do, or from the Himyaritic characters of Yemen as Lenormant alleges. The traditional belief of the Hindus that their ancient literature was handed down by oral recitation alone is thus confirmed, and a remarkable illustration afforded of the powers of a trained memory. The famous maxim that a literature cannot exist without writing must be given up, and the rigid sceptics who refuse to admit that any historical truth can be extracted from oral tradition lose their most formidable argument.

The earliest material used for writing purposes in India seems to have been the bark of the *bhûrja*, which is usually identified with the birch. It is worth notice that our own word *book* has the same origin as *beech*, and testifies to a similar employment of the bark of the beech-tree among our Teutonic ancestors. It is probable, however, that the characters of our first "books" were cut upon the soft wood or bark of the beech in the form of runes, and not painted as in the case of the birch books of ancient India. Nevertheless we must not forget that Venantius Fortunatus when alluding to the runes in the seventh century speaks of them as being "painted" on tablets of ash.

A. H. SAYCE

OUR BOOK SHELF

Parasites; a Treatise on the Entozoa of Man and Animals, including some Account of the Ectozoa. By T. Spencer Cobbold, M.D., F.R.S., F.L.S. (London: J. and A. Churchill, 1879.)

THERE are several groups of animals which from time immemorial have been more or less generally neglected by zoologists, and which have induced but very few amongst the latter to make a specialty of their investigation. As an instance of comparatively highly developed animals to which this remark applies, we need only point to the whole class of cephalopoda, and among the lower animals the entozoa are certainly a good case in point. Apart from the comparative scantiness of the literature treating of these animals, it has the additional disadvantage, in common with much other zoological literature, of being scattered in the numerous volumes of several hundred different scientific serials. Dr. Cobbold has for a long time been held an eminent authority on helminthology, and, as he states in his preface, many hundreds of correspondents, not having ready access to the works of Rudolphi, Diesing, and Dujardin (three great foreign authorities on the subject), have applied to him for identification of parasites they met with in dissections or otherwise. He therefore pronounces the most justified hope that by the work now published a reasonable limit may be placed upon the number of future applicants. What particularly characterises Dr. Cobbold's work is the thoroughly scientific enthusiasm with which it is written, and which in itself is admirable. We cannot help reproducing the closing sentences of the preface, which will give to our readers a true notion of the spirit to which, according to our view, a scientific work ought to owe its origin:—

"The study of the structure and economy of a humble parasite brings to the investigator no slight insight into the workings of nature. If these workings cannot at all times be pronounced to be 'good and beautiful,' they must at least be characterised as 'true.' The knowledge of the true—especially if that knowledge by its practical applications be calculated to confer substantial benefits upon man and his inferior fellow-creatures—ought to be held in high esteem; but apart from this purely utilitarian view, there remains for the investigator the delight occasioned by the inrush of new scientific ideas. The average mind, being either essentially commercial or ridiculously sentimental, as the case may be, is totally incapable of comprehending the motive power that animates and guides the votary of science. The late Prof. Faraday, a man wholly untinged by the ambitions of wealth and power, once remarked to me that there were no people so difficult to instruct as those who were ignorant of their own ignorance. It is just these very persons who, when placed in high positions of social, political, or professional trust, most powerfully contribute to check a nation's progress. There are too few genuine workers at science in this country. As one of the rank and file I claim only to have honestly contributed my mite. I should like to see a small army of helminthologists rise up and lay siege to the fortresses at present securely held by thousands of death-dealing parasites." None but an honest and true worker will write such sentences as these; every well-meaning man of science must concur with Dr. Cobbold in the ideas he thus forcibly expresses. Upon an array of workers of Dr. Cobbold's stamp a nation may justly look with pride.

Turning now to the book itself we need hardly say that the author has executed the task he set himself in a most praiseworthy manner. Apart from a voluminous contribution of original work, he has consulted an almost interminable list of bibliographies on the various kinds of parasites, a work which in itself involved stupendous labour.

The contents are divided into two large groups, the parasites of man occupying the first division, and those of animals the second. Each division is subdivided into several sections, and thus in the first we have descriptions in one section of Trematoda or flukes, in the other those of Cestoda or tapeworms, in the third those of Nematoda or round- and thread-worms, and in the last those of Acantocephala (thorn-headed worms), Suctoria (leeches), and the parasitic forms of Arachnida, Crustacea, Insecta, and Protozoa. In the second division the parasites of animals are arranged according to the respective places of their hosts in systematic zoology. The parasites of Mammalia are subdivided according to the orders in this class, beginning with Quadrumana and ending with Marsupialia and Cetacea. After this the parasites of birds, reptiles, fishes, and invertebrate animals are considered in due course. In relation to the parasites of man, the author gives a great deal of valuable statistical information which must be of special interest to the physician.

Altogether we cannot speak too highly of Dr. Cobbold's book, and congratulate the author warmly upon having so efficiently filled a gap in zoological literature, the existence of which had long been felt by all working naturalists and many medical men.

A Contribution to Agricultural Botany. By A. S. Wilson. (Aberdeen: J. Rae Smith, 1879.)

THE author of the small volume before us is already favourably known as an investigator of more than one obscure yet important problem connected with field-botany. The text of his present discourse is "turnip-singling." He approaches this subject in a characteristically careful manner, taking into account, as he does, a number of considerations which might easily escape the attention of an ordinary observer or experimenter. The object and manner of his experiments present no novelty; indeed, it seems to us that Mr. Wilson can hardly be fully aware of the immense number of trials which have been made, both in this country and on the Continent, in order to ascertain the best distance apart for swedes and turnips. However, experiments of this order certainly require frequent repetition in order that the influence of season, climate, soil, and manure, may be duly measured. Any one of these conditions may so affect the result as to invalidate a hasty conclusion drawn from one or two years' trials, even when such trials have been conducted, not in one locality, but in several. Mr. Wilson is quite

right in saying that "the theory of no farm plant has been worked out," and that "our turnip shows are conducted on no useful principle." But he is not equally correct in affirming that "the chemist of the Aberdeenshire Agricultural Association initiated a most important mode of teaching one aspect of cultivation," or that questions in agricultural botany "have usually been altogether subordinated to questions on the comparative efficacy of manures. Had Mr. Wilson known the range of work and style of teaching until lately prevailing at Cirencester, and for long and now in vogue in many agricultural colleges in America and on the Continent, he would have hesitated before making such statements.

While Mr. Wilson shows us how, under certain conditions, a larger weight per acre of roots was produced when the plants (both turnips and swedes) were singled so as to leave but 6 inches between them in the drills, although the drills themselves were 27 inches apart, he gives us no information as to the relative feeding values of the larger roots grown at 8 and 9-inch intervals, and the smaller but more numerous roots from the 6-inch intervals. Had the average weight of any of these sets of roots been exceptionally high or exceptionally low, this point would have been of much greater importance. For our object in growing such a crop as turnips or swedes is to obtain the most economical production of the greatest amount of wholesome and keeping food per acre. Very large roots are, we know, very watery, do not keep well, and contain certain nitrogenous and saline matters in excess, so as to become in this way also less desirable as food for farm stock. And it frequently happens that *all* the increase per acre obtained in the form of large roots is water or useless mineral matters. Thus, in all experiments, such as these of Mr. Wilson, fair samples of the crop from different plots should be reserved for analysis—water, ash, and albuminoid nitrogen, at all events, being determined in the produce of each plot.

Arithmetic in Theory and Practice for Higher and Middle Class Schools, &c. By Henry Evers, LL.D. (London and Glasgow: W. Collins, Sons, and Co., 1878.)

HAD Dr. Evers been entirely unknown to us, we should have had no hesitation whatever in saying that this is the work of a practical teacher; of one who has fully realised the difficulties of "teaching arithmetic," and by long experience and patient observation learnt to cope with those difficulties successfully. The arrangement is unquestionably good and in some respects original; the definitions and explanations are short and to the point, indeed we could wish in some cases the author had made them fuller; the problems are numerous and interesting and more of the ordinary daily business type than fanciful improbabilities; and the solutions as far as we have examined them remarkable for accuracy.

The author might have given another method for the extraction of the cube root applicable to all roots; those he gives are certainly the best we remember seeing in any text-book. The examination questions at the end will be found of very great value to those preparing for similar ordeals. The publishers have as usual given a good book a good dress as regards paper, type, and binding.

E. H.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Recent Weather

IT is not necessary to appeal to statistics to demonstrate the cold and sunless character of the weather nearly constantly experienced during the last few months, this being matter of the most ordinary observation; nevertheless some more exact information on the subject may not at the present time be unacceptable to the readers of NATURE.

The year 1878 until October had been generally warm, the temperature on the whole having been above the average in every month, excepting September, and it was very little below in this month. Then a period of cold set in. Beginning with 1878, November, the temperature has been in every month below the average, the deviation in some months being very large. The amount of sunshine, as recorded by Campbell's instrument, has also, since April, been in each month remarkably small. A few particulars, extracted from the Royal Observatory Records, by permission of the Astronomer-Royal, are given in the following table:—

Month, 1878–1879.	Deviation of mean temperature from average of twenty years.	Number of days on which the mean temperature was		Hours of bright sunshine.	Deviation of amount of sunshine from average of the two preceding years.
		Below the average.	Above the average.		
November ...	−3°·0	25	5	40·5	− 5·8
December ...	−7·1	25	6	16·3	− 0·4
January... ...	−6·9	26	5	14·8	−12·1
February ...	−1·5	16	12	31·7	− 2·9
March	−0·3	14	17	91·0	+ 4·8
April	−4·3	25	5	74·6	−36·5
May	−4·7	27	4	135·6	−21·0
June	−2·9	26	4	141·9	−83·3
July (to 19th)..	−5·8	19	0	52·9	−51·6

The sign − indicates *below* the average.

In every month the temperature has been below the average. The generally severe character of all the months, excepting February and March, is well shown in the column giving the number of days on which the temperature was below the average. From April 1 to July 19, a period of 110 days, 97 were below the average. And during the same period the hours of bright sunshine numbered only 405·0, which is 192·4 hours less than the average of the same period in the two preceding years, or 0·68 only of the amount registered in those years.

Royal Observatory, Greenwich, July 23 WILLIAM ELLIS

Some Remarks on the Rev. J. G. Wood's Explanatory Index to "Waterton's Wanderings"

1. THE name of the Indian tribe mentioned ought to be *Tamanacos* and not *Jamunacs.*

2. The botanical name of the arrow-reed is *Gynerium* (not Gynœcinm, p. 372).

3. (P. 378).—The Balata gum has reached the English market long ago, though it may have disappeared again. If I do not mistake there existed about 1864 even a Balata Gum Company, in which Messrs. Silver and Co. took the lead. We have in Venezuela (State of Maturin) the same tree, where it is called Purvio. Mr. d'Azevedo, of Maturin, sent several times quantities of the gum to Hamburg, but I am informed it did not pay.

4. (P. 380).—The *Camoudi* is *Eunectes murinus* (not marinus). Mr. William Crookes in his article "Gravitation as a Factor in the Organic World" (*Journal of Science*, January, 1879, p. 42), calls it aquatic, and says that it inhabits the rivers of South America. This is certainly wrong; it is generally found near the water, and swims very well, but is by no means an aquatic animal.

5. (P. 381).—*Copaiva* is an oleo-resin, and should not be called a *gum*. There is on p. 461 a misprint in the name of the tree from which it is obtained. It is *Copaifera pubiflora*, Benth., not *C. publiflora.*

6. (P. 383).—The name of the describer of the birds of Trinidad is *Léotaud* ("Oiseaux de l'Ile de la Trinidad," Port d'Espagne, 1866).

7. (P. 384).—The castor-oil plant belongs to the family of Euphorbiaceæ, but not to the tribe of Euphorbiæ (or better Euphorbieæ).

8. (P. 385).—Read *Anolis* instead of *Anolius.*

9. (P. 394).—The coffee-tree does not belong to the "useful

group of Cinchonaceæ," which is distinguished by numerous seeds in each carpid, though both are included in the same family of Rubiaceæ.

10. (P. 407).—The conical mound of the Flamingo is not at all an error in natural history. I have seen several of these nests with the eggs on the top of the heap on the Roques Islands, north of La Guaira.

11. (P. 412).—*Vulpes cancrivorus.* There is no species of true *Vulpes* in South America, if we follow the distinction established by Burmeister ("Syst. Uebersicht der Thiere Brasil.," i. 92), and the animal in question is undoubtedly the *Canis cancrivorus*, Desm.

12. (P. 431).—"Kurumanni Wax. This is composed of the wax of a wild bee (*Ceroxylon andicola*), mixed with a pitch-like substance obtained from several trees, chiefly the Maam-tree." It is scarcely possible to believe that the accomplished editor of the "Wanderings" should have penned these lines, where a noble palm of the Andes is changed into a wild bee. The latter is most likely a species of *Melipoma*. The *Kurumanni wax* may be identical with a pitch-like substance, called *Caraman*, *Paraman*, or *Peraman* in Venezuelan Guayana, and which is obtained from *Moronobœa coccinea*, Aubl.

13. (P. 434).—The mahogany tree belongs to the family of Meliaceæ, but not to the group of Cedraceæ (or better Cedreleæ).

14. (*Ibid.*).—*Maribunta* is not a Portuguese word signifying a wasp. In Brazil the word *maribondo* is used for a certain species of wasp, but the name is taken from the Tupi language.

15. (P. 440).—*Mosquito.* Even in popular works on natural history authors should call everything by its real name, and it is therefore altogether wrong to speak of the *bites* of mosquitoes; *sting* would have been just as short, and evidently more correct.

16. (P. 447).—*Pataca.* Perhaps we may read *paraca*, one of the names of *Ortalida motmot*, Wagl.

17. (P. 473).—*Sting Ray. Trygon pastinaca* is a maritime species; but there are several other ones in South American rivers, as *Tr. hystrix*, &c.

18. (P. 473).—*Sugar cane* is *Saccharum* (not *Saccharinum*) *officinarum.*

19. (P. 474).—"The tiger-birds derive their popular name from the peculiar cry which they utter." What powerful lungs they must have, these tiger-birds, in order to be able to roar like a jaguar! This singular blunder might have been avoided by reading carefully what Waterton says (p. 195), that it has no song, its name being due to the black spots on a yellow ground on breast and belly.

20. (P. 475).—The tortoise of Guayana, as far as I know, is *Testudo tabulata*, called *Morrocoi* in Venezuela. *Cistudo carolina* is a North American species.

21. (P. 236).—*Chigoe.* What Waterton says of the hatching of this animal *within* the body of man is certainly not true. The eggs are developed outside, the larvæ leading a free existence.

Some of the foregoing remarks refer to mere clerical errors (a good many less important ones having been passed over in silence); but there are unfortunately not a few inaccurate, and even wholly erroneous statements which we were sorry to find in this *Explanatory Index*. A. ERNST

Caracas, May 15

Swift's Comet.—Williams College Observatory

I HAVE computed a set of elements of the comet lately discovered by Mr. (now Dr.) Swift. They are from observations made by Prof. Lewis Boss, Director of the Dudley Observatory at Albany, on June 24, June 30, July 8. They are these:—

T April 27·1801, M.T. Washington.

log. q	9·950918	
ω[1]	3° 28′ 13″·0	M.Eq., &c., 1879·0.
☊	45° 41′ 10″·5	
i	107° 1′ 53″·6	

For the middle observation $c - o$ $\Delta\lambda + 0''\cdot6$

$\Delta\beta + 0''\cdot3$

Or in space, both co-ordinates, about $0''\cdot5$.

They were computed by Olbers' method, afterwards varying *M* by the regular rule. A trifling change of *M*, which I have not now time to make, would bring a closer representation of the middle observation; say to about $+0''\cdot2$ and $-0''\cdot1$ in longitude and latitude respectively.

I am happy to say that the observatory of this college is to be repaired and put into active operation. It is about forty years old—the oldest I believe in the United States—and was built by the late Prof. Albert Hopkins. It now contains a $7\frac{1}{4}$ inch equatorial, an early work of Clark; a $3\frac{1}{2}$-inch Simms transit, of the style of forty years ago, with a very poor object-glass; and a sidereal clock by Molyneux and Cope, still in good order. I have been authorised by the Hon. David Dudley Field to procure a meridian circle with telescope of about 5 inches aperture.

The gentleman just named is the founder of my professorship, the "Field Memorial Professorship of Astronomy," and it is probable that in future a portion of the duties of that professorship will consist in making observations, and in their complete discussion. TRUMAN HENRY SAFFORD

Williams College, Williamstown, Mass., U.S.A., July 11

[1] Dist. of perihelion from node.

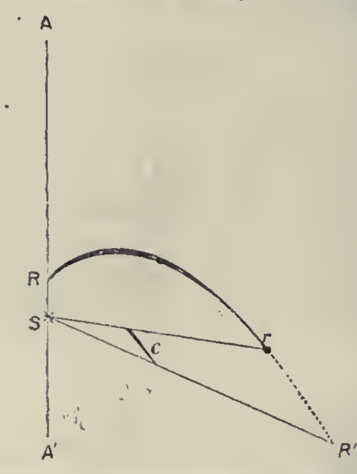
Electric Lighting

IN the evidence given before the Committee on Electric Lighting, some mention was made of the difficulty of equalising the light over any considerable area; but it is worth while to remark that by a simple form of reflector it is possible to make the light very approximately uniform over an area whose radius is twice the height of the lamp above the ground. For imagine a sphere with the lamp as a centre and its height above the ground for radius. Supposing the lamp radiates equally in all directions, the surface of this sphere will be uniformly illuminated, and its surface has an area $4\pi h^2$. If now we take a plane circular area about the foot of the lamp-post with radius R such that—

$$\pi R^2 = 4\pi h^2 \text{ or } R = 2h,$$

it is plain that by a proper distribution by reflection of the light which would pass through the imaginary sphere outside the solid angle subtended at the lamp by the plane circular area, the illumination over that area may be made uniform and equal in intensity to that near the foot of the lamp-post.

To find the proper form for the reflector, which is of course a surface of revolution, it is necessary to find the angle which



each zone of the reflector subtends at the lamp in terms of the angle in which the light is reflected by it. This is given by the equation—

$$\sin\phi\, d\phi = \left(\frac{1}{\cos^3\theta} - 1\right) d\theta,$$

with the condition $\phi = 0$, when $\theta = \tan^{-1}2$, where taking the lamp-post as the polar axis, the upper end being north, $(90 - \phi)$ is N. latitude of that zone of the reflector which sends out its light in S. latitude $(90 - \theta)$. The polar differential equation of the curve for the reflector may then be easily found; it is—

$$\rho \frac{d\phi}{d\rho} = \cot \frac{\theta + \phi}{2}.$$

A figure of the curve is given below at R R′. The surface of the reflector is swept out by the revolution of R R′ round A A′. The dotted portion r R′ should be replaced by a separate zone shown at c, but the chief value of this will be as a screen to prevent the light from being visible at low altitudes, the small quantity of light reflected by it merely going to reinforce the illumination in the immediate neighbourhood of the lamp. Such reflectors might be applied with great advantage to powerful lights placed at considerable elevations. A. MALLOCK

Brampford Speke, near Exeter, July 14

Did Flowers Exist during the Carboniferous Epoch?

THE systematic position of the genus *Breyeria*, founded for the reception of a fossil insect, having formed the subject of a recent discussion in NATURE (vol. xix. pp. 554, 582), I have just visited Brussels to examine the original type. Through the courtesy of M. de Borre I have been allowed to submit it to a careful microscopical scrutiny, and have sketched, with the aid of a camera lucida, a considerable part of it on a large scale. The facies of the neuration is extremely similar to that of genera allied to *Palingenia* of the Ephemeridæ, resembling theirs not only in the relative abundance of cross-veinlets, but also in the manner of the aberrations of abnormal cross-veinlets. The *Palingenia* group is sufficiently elastic to comprise *Breyeria*, although this differs in detail to some extent from any known genus of recent Ephemeridæ.

May I be allowed to suggest that if photographs of fossil insect-remains be taken for critical purposes, it would be advantageous to execute them on a scale of considerable enlargement. In the present instance it was far easier to distinguish nervures from mechanical depressions in the stone when a 3-inch object-glass was employed, than when a 4-inch glass was in use. These are the lowest powers that I have with me, excepting simple lenses. *Apropos* of fossil insects, there is in Baron E. de Selys Longchamp's collection, a species of recent *Homoptera*, which is likely to be of interest to palæontologists. At first sight it resembles a fragmentary specimen of Ephemeridæ so closely that it was actually reserved for my inspection as such. Viewed through a weak lens, it would appear from its anterior wings to be a representative of the Planipennes, allied more or less to *Panorpa* perhaps. A more careful examination, however, reveals its rostrum and other characters distinctive of its real nature. Its exact affinities have still to be ascertained; but in all probability it is something new and extraordinary. A. E. EATON

Rotterdam, July 24

The Papau

I WAS surprised to read Capt. Oliver's statement in NATURE, vol. xx. p. 241, that the papau (*Carica papaya*) is not eaten by birds in Bourbon and Mauritius. In Samoa it is eaten largely by birds—especially by *Sturnoides atrifusca*, and also by bats of the genus *Pteropus*. The seeds of this fruit appear to have been carried by the agency of birds over at least a great portion of the islands. I have seen many places where the virgin forest has been cleared, and in every instance—as far as my memory serves me—a thick crop of *Carica* appeared as soon as the clearance was made. They do not grow while the forest stands, but spring up in thousands as soon as light is let in to the soil.

S. J. WHITMEE

17, Leinster Square, Rathmines, Dublin

Intellect in Brutes

I HAVE just been watching with care the action of a party of ants, exhibiting an intelligence nearly allied to reason, if indeed it be not "reason."

Clearing the shelf in a hothouse, two large cockroaches were caught, killed, and left lying on the small gravel with which the shelf is covered. This shelf is four feet from the floor, and the nest of the ants is behind a slab at the end of the house. When the cockroaches were killed, very few ants were upon the slab, but they must have communicated to others the discovery of the treasure, for in about twenty minutes a swarm of ants emerged from the nest, climbed the wall, gained the shelf, and there, dividing into two parties, proceeded to take possession of the dead bodies.

To understand the significance of what I am about to relate, it is necessary to form a distinct conception of the comparative sizes of the ant and the cockroach. The ant was the smallest of its kind; the body of its prey was nearly two inches long and half an inch in width. The proportions were to each other as would be those of a man to the dome of St. Paul's. Their purpose was to carry these two huge carcases to the nest, and to accomplish this it was necessary, first, to draw them for a space of ten inches over rough gravel, then along a smooth board for two feet, then to drop them to the floor beneath, then to drag them over some very rough rubble for one foot four inches, and finally to pass them between two slabs of wood into the nest. This extraordinary feat they performed successfully. It was accomplished thus: They surrounded the corpse of the dead cockroach and seizing it with their mandibles, moved it onward a little way. It was lying inclined on its side. When moved, the projecting edges of the side hitched in the stones and prevented progress.

I observed that, on some larger stones near the spot, half a dozen ants stood looking at the work, but taking no part in it. When the hitch occurred, and always afterwards when there was an obstacle, these "surveyors" left their stations, went to the workers and then returned to their place of observation. They were manifestly directing the operation and instructing the labourers; and they as manifestly made some communication to the labourers, for forthwith these changed their plan. They now turned the cockroach on its back, and in this position they moved it onward triumphantly for three or four inches. How? They stood round the corpse at precisely equal distances apart and by a common effort dragged it forward. They pulled together, apparently in obedience to a signal from the "surveyors," just as men shout when *they* want to pull together.

Another obstacle. Three pieces of gravel bigger than the rest lay in their path. What to do now? They crept under the carcase and lifted it by planting the hind feet on the floor and standing upright, sustaining the load with their heads, while a party mounted the opposing stone, seized the tail, and tried to drag the burden up. But in vain. It was too much for their strength and the load was dropped.

Then the ants that had been directing again moved from their places and ran rapidly about in all directions, as if seeking some more easy passage. Having found one they remounted their post of observation and it may be assumed that they gave some intelligent orders to the labourers, for immediately these resumed their hold upon the carcase and moved it forward in the new direction indicated.

Similar obstacles occurred four times in the course of their journey over the gravel, and on each occasion the same proceedings were observed. Their patience was inexhaustible. At length the body was successfully brought to the smooth edge of the wooden shelf, whence it could be dropped to the floor beneath. But it was necessary to select a fit spot for this purpose, inasmuch as the floor was strewn with bricks and plants. In fact there was but one open space of about four inches square into which the body could be sent so as to be carried securely to its destination. To reach this spot they had to drag the burden along the ledge for a space of 17 inches. In this journey balance was repeatedly lost and the carcase would have fallen, but that it was seized, held, and dragged back by their united efforts. At length, having arrived at the place where its fall would be upon the open floor, it was dropped by all at once losing their hold of it. But previously to their doing so, the "surveyors" ran down the wall to the floor and posted themselves directly under the ledge on which the body lay (4 feet above them). There they waited its fall. I think their business there was to see if all was safe and the place really fit for the purpose, and that they made some communication as to the precise spot to be chosen for the fall, for the ants who bore the corpse shifted it two or three times before they let it down. Then all followed, running down the wall, seized their prey again, and in half an hour carried it a distance of nearly 3 feet to the entrance of the nest.

But here another difficulty occurred. It could not pass between the boards when lying upon its back. They turned on its side and tried again. Again they were baffled; the legs hitched. So they turned it on its back once more, bit off the legs, which were carried into the nest by other ants, and then the body was turned on its side and taken through the narrow way into the nest. To me, looking at it with the eyes of a psychologist, all this seemed to indicate the exercise of a *reasoning* faculty. They devised new methods of meeting new circumstances. It satisfied me, also, that ants at least have means of intercommunication. The fact of the find was obviously communicated by the discoverers. The workers manifestly acted under instructions and obeyed commands.

My object in this communication is merely to place upon record a very remarkable proof that the lower animals have intelligence very like our own. EDWARD W. COX

Moat Mount, Mill Hill, N.W., July 26

AS you are publishing notices of intelligence in brutes perhaps the following example of memory in a bird may be interesting. When I returned from the Pacific about two years ago, I brought

a sulphur-crested cockatoo (*Cacatua galerita*) from Australia. Soon after my arrival in England I had occasion to cut his wing, and this destroyed all his former friendly feelings towards me. On my removal from Blackheath to Dublin, I placed him for a few weeks in the Zoological Society's Gardens, Regent's Park. Being in London in May I brought him with me on my return to this city. I went to the Gardens for him myself, and was interested and somewhat pleased to find, on speaking to him, that he had apparently forgotten me. On my way, in a cab, to the hotel where I was staying, he was very friendly; but on my arrival there, as soon as I took off my hat, it was evident that he recognised me, for his old manner at once returned. On arrival here he appeared to remember my children, and resumed his former friendliness towards them, but he still regards me as his enemy.

17, Leinster Square, Rathmines, Dublin S. J. WHITMEE

Proceedings of the Aberdeenshire Agricultural Association, 1878

YOUR article (vol. xx. p. 288) touches a subject of vital importance to the farmer in these bad times, and I hope you will follow it up by an appeal to Mr. Lawes and to the Royal Agricultural Society of England to institute a parallel and independent course of experiments, in order to test the conclusion in regard to phosphatic manures announced by the Scotch Association.

The possible presence of humic, carbonic, and other acids in more than usual proportion in Aberdeenshire soil and water has often occurred to me as accounting for the similarity of results between those local experiments of soluble and insoluble phosphates, but it can hardly be denied that a case has been established for further experiments. The fact that acid and manure makers have a direct pecuniary interest in the existence of a prejudice in favour of *soluble* phosphate might alone have led farmers to require some evidence before spending their money under such scientific dictation, but now that they have three years' experiments testifying distinctly against the doctrine, they may surely look to their advisers for something more than bare assertions on authority that a "mineral phosphate is of little or no value as a maure until it has been rendered soluble by acid in course of manufacture." ALFRED S. JONES

Wrexham, July 27

Spicula in Helix

WHILST dissecting, a few days ago, a common garden snail (*Helix aspersa*), I came across two calcareous spicula, lying immediately under the "albuminiparous gland," which I cannot find mentioned in any of the text-books. I at once dissected three other snails of the same species, and in two I found no spicula, while in the third I found one lying in the same place as the two before-mentioned. Can any reader of NATURE tell me whether these are of the same nature as the diffused spicula of Doris, or if not, of what nature they are? They could not have been "spicula amoris" (Huxley) of the dart-sac, as they were not contained in any sac at all, but were lying free in the above position. EDWD. B. PARFITT

3, Waterfield Terrace, Blackheath, S.E.

GENERAL RESULTS OF EXPERIMENTS ON FRICTION AT HIGH VELOCITIES MADE IN ORDER TO ASCERTAIN THE EFFECT OF BRAKES ON RAILWAY TRAINS[1]

II.

SOME special experiments were made with blocks of small area. The brake-blocks generally used in these experiments were 12 inches long, by 3 inches wide, giving a surface of 36 square inches; the small brake-blocks were made so as to afford a surface of pressure against the wheel of only one-third of this amount, or 12 square inches, thus making the pressure per square inch three times as great as before. The diminution of surface was obtained by casting projections upon the face of the block. The author is not prepared to say that any greater coefficient of friction was obtained by the extra pressure per square inch, although in one of the experiments, at a velocity of sixty miles an hour, the rotation of the wheels was arrested by these blocks, whilst this effect had not been produced at that speed in other experiments. The experiments on this form of block were stopped because the blocks were entirely worn down in the course of about twelve experiments.

Mr. Rennie showed[1] that high pressures per square inch produced a greater coefficient of friction between surfaces either moving very slowly or nearly at rest; but it must be borne in mind that the author's experiments were made with high velocities, whereby a serious element of disturbance is introduced, viz., the grinding away of the surface; and it is therefore probable that the increase in the coefficient of friction due to increased pressure, may have been neutralised by the lubricating effect of the fine particles ground off the surfaces.

While no certain opinion can be expressed as to the relation which the coefficient of friction bears to pressure, so far as these experiments are concerned, it is quite clear that in proportion as the pressure is increased or diminished so will the actual friction obtained be increased or diminished. When the friction which exists between the brake-blocks and the wheel reaches a certain point, the wheel ceases to rotate, and becomes fixed. This point is reached when the frictional resistance of the blocks exceeds the adhesion between the wheel and the rail if the speed is kept up; or, if the speed is slackening, when it exceeds the adhesion between the wheel and the rail, plus the effort required to retard the rotation of the wheel equally with the retardation of the train; and the excess of resistance then acts as an unbalanced force, tending to destroy the momentum of the wheel.

Usually there are in a train a certain number of vehicles braked and a certain number unbraked. If the brakes acted on all the wheels, then the rotating momentum of the wheels does not add to the distance in stopping a train, because that momentum can be acted upon by the brakes directly, without in any way affecting the adhesion of the wheels to the rails. It simply requires an additional amount of brake-block pressure.

With the unbraked portion of a train the rotating momentum of the wheels is an addition to the momentum due to the weight of the train (including therein the actual weight of the wheels), which cannot be utilised for retardation; and it therefore seems important that there should be brakes on every wheel of a train.

As it thus appears that it is the adhesion which governs the retardation which the brake-blocks can exert upon wheels, it is manifest that the pressure brought to act on the brake-blocks should never give an amount of friction which exceeds the adhesion. At a high speed, however, the pressure required to produce a degree of friction equal to the adhesion is much greater than what is required at a low speed.

The following table gives approximately the proportion which the pressure to be applied to the brake-blocks should bear to the weight upon the braked wheels, with coefficients of adhesion between wheel and rail varying from ·30 to ·15 of the weight on the wheels :—

Ratio of Brake-Block Pressure to Weight on Wheels

Speed.		Approximate ratio of total pressure on brake-blocks to total weight on braked wheels.			
Feet per second.	Miles per hour.	Coefficient of adhesion 0·30.	Coefficient of adhesion 0·25.	Coefficient of adhesion 0·20.	Coefficient of adhesion 0·15.
11	7½	1·20	1·04	0·83	0·60
22	15	1·41	1·18	0·94	0·70
29	20	1·64	1·37	1·09	0·82
44	30	1·83	1·53	1·22	0·92
59	40	2·07	1·73	1·38	1·04
73	50	2·48	2·07	1·65	1·24
88	60	4·14	3·47	2·77	2·08

[1] Continued from p. 295.

[1] *Phil. Trans.* for 1829, p. 159.

It will be seen that, when the adhesion equals ·30 of the weight, a pressure equal to 1·2 of the weight would skid the wheel at $7\frac{1}{2}$ miles per hour, whilst a pressure equal to 4·14 times the weight would be required to do so at 60 miles per hour.

On the other hand, if the adhesion is only ·15, the pressure requisite to skid the wheel would be only ·60 of the weight at $7\frac{1}{2}$ miles per hour, and 2·08 of the weight at 60 miles per hour.

Thus the efficiency of a brake depends upon the pressure being proportioned to the speed and to the adhesion. If the adhesion were always uniform, the rule would be very simple; but this is not the case.

The adhesion of the wheels to the rails varied according to the materials, that is, whether the train was travelling upon iron or steel rails; and according to the state of the rail, whether dry, wet, or sanded.

On dry rails it was found that the coefficient of adhesion of the wheels was generally over ·20. In some cases it rose to ·25, or even higher. On wet or greasy rails, without sand, it fell as low as ·15 in one experiment, but averaged about ·18. With the use of sand on wet rails it was above ·20 at all times; and when the sand was applied at the moment of starting, so that the wind of the rotating wheels did not blow it away, it rose up to ·35, and even above ·40. Consequently, the retarding effect of the brakes would be greatly increased, were means devised for placing sand under every wheel to which a brake is applied, during the progress of a stop.

The effect in stopping a train is greatest when the friction between the brake-blocks and the wheels amounts to a quantity just short of the resistance caused by the adhesion, because as soon as the brake-block friction exceeds the adhesion, the wheel becomes fixed and begins to slide. In order, however, to secure the best results in stopping, it is obviously necessary that the brake-block pressure should be regulated to give a friction about equal to the adhesion of the wheels at every stage during the progress of a stop.

There is no reason why, in the progress of mechanical science, these conditions should not be regulated by a self-acting arrangement.

Mr. Westinghouse has devised a valve to regulate the pressure between the blocks and the wheels. The principle of the valve is, in the first place, to prevent the actual friction from exceeding the adhesion at any point; and in the next place, whilst allowing the fullest amount of pressure necessary to produce the maximum friction to be applied to the brake blocks when the brakes are first put on, that is to say, when the speed is high at the commencement of a stop, to reduce that pressure gradually during the progress of the stop, so as to maintain as nearly as possible a uniform amount of friction.

As the adhesion varies it is necessary to consider what amount of adhesion for purposes of retardation can be safely calculated upon.

The following table shows the distances required to stop a train on a level line from a speed of fifty miles per hour, with a retarding force of from 5 to 30 per cent. of the total weight of the train:—

Percentage of retardation.	Yards run at fifty miles per hour.	Percentage of retardation.	Yards run at fifty miles per hour.
5	$555\frac{2}{3}$	18	$154\frac{1}{3}$
10	$277\frac{2}{3}$	20	139
12	$231\frac{1}{3}$	25	111
15	185	30	$92\frac{2}{3}$

If the brakes act upon each wheel, then a retardation of 10 per cent. of the load carried by each wheel—counting the rotating momentum as part of the weight—will stop a train in $277\frac{2}{3}$ yards.

If the brakes act upon only half of the weight of a train, a retardation of 20 per cent. would have to be exerted upon the braked half to produce the same result. As pointed out, 20 per cent. adhesion is rather above the average obtainable, while 25 per cent. is the highest result obtained under the most favourable circumstances at any considerable speed, or except when sand was applied to wheels moving slowly.

The above table should be carefully noted, for it will be seen that, even if brakes act upon all wheels, 25 per per cent. retardation will only give twenty-eight yards better result than 20 per cent., or if half of the train only be braked, it will give fifty-nine yards advantage.

A consideration of this feature of the brake problem points out (1) that the advantage to be gained by trying to obtain above 20 per cent. retardation on each wheel is greatly overbalanced by the risk of "skidding;" and (2) that it is far easier and safer to make a stop in 250 yards from fifty miles per hour with the whole train braked, than with brakes upon only half of the train.

The following are some of the results of the earlier experiments, obtained with Mr. Westinghouse's pressure-regulator:—

No. of experiment.	Gradient.	Speed. Miles per hour.	Condition of stops.			Total brake block pressure, P, on the four wheels.			Percentage of brake block pressure to weight on wheels.		Observed coefficient of friction between brake blocks and wheels on one pair of wheels.			Mean retardation calculated from stop.
			Time of stop. Seconds.	Distance run in yards.	Distance reduced to fifty miles per hour. Yards.	Maximum.	Middle of experiment.	End or at skid.	Maximum at commencement of experiment.	Minimum at end of experiment.	At moment when maximum pressure was obtained.	At middle of experiment.	At end of experiment.	
1	$+\frac{1}{264}$	60	$12\frac{3}{4}$	171	118	32370	31200	23010	160	114	·129	·125	·241	23·3
2	$+\frac{1}{311}$	60	$12\frac{1}{4}$	167	116	32760	30810	29250	162	145	·145	·161	skid	23·9
3	$+\frac{1}{330}$	55	$10\frac{1}{2}$	141	116	28470	27690	16380	141	81	·160	·176	·31	23·8
4	$-\frac{1}{400}$	57	$18\frac{1}{2}$	223	171	24570	15990	7800	122	39	·157	·158	·35	16·8
5	Level last thirty yards $-\frac{1}{170}$	55	18	227	194	17550	14430	8190	87	40	·161	·182	·309	14·3

In the second experiment the pressure was not reduced with sufficient rapidity to prevent the skidding, and in the fourth and fifth experiments the pressure was insufficient at the beginning of the experiment. From these and

other experiments it was found that the best results were obtained in cases where the pressure applied at first was from about 1¾ to twice the weight on the wheels, and where the reduction of the pressure was effected with sufficient rapidity towards the end of the stop to prevent the friction being sufficient to skid the wheels.

The necessity for the instantaneous application of the maximum brake-block pressure throughout the train is evident from the fact that, at a speed which is frequently obtained, namely, 60 miles per hour, a train passes over 88 feet each second; therefore the loss of two or three seconds in applying the brakes means often the difference between safety and danger, and the rapidity of a stop largely depends upon the rapidity with which all the brake-blocks can be brought to act against the wheels of a train.

This points to the advantage of being able to move the brake-blocks with great rapidity from their position of inaction to that of contact with the wheels; because it is essential to provide that the brake-blocks, when out of use, shall be removed to a distance from the wheels sufficient to prevent the possibility of their dragging against the wheels, and thus retard the progress of the train. The question of the rapidity with which brakes can be applied in practice is thus one of much importance.

Some experiments were made in October, 1878, upon the North Eastern Railway, on a train fitted with the vacuum brake, and one fitted with the Westinghouse brake to ascertain the time which was required after moving the brake-handle to set the brakes with various degrees of force in different parts of the train. The following table shows the result arrived at :—

Place of experimental van from engine.	Vacuum brake.				Westinghouse automatic brake.			
	Commencement of movement of blocks.	Half on.	Three-quarters on.	Full on.	Commencement of movement of blocks.	Half on.	Three-quarters on.	Full on.
	secs.	secs.	secs.	secs.	secs.	secs.	secs.	secs.
1st vehicle	⅓	3	7	11	¼	⅝	¾	1½
7th ,,	2	6½	8⅓	14	1	1¾	2	2½
13th ,,	3⅓	7½	9⅓	14	1¾	2¾	3⅛	3½
21st ,,	5½	17	30	—	3	4½	5	5½

A long interval of time between brakes coming on at the front and rear of a train may become a source of danger; and improvements have been introduced in both the vacuum and Westinghouse apparatus since that date to reduce the interval as shown by the experiments.

In the Westinghouse brake a simplified triple-valve has been adopted, the friction has been reduced by the use of an enlarged pipe and by the removal of bends in the connections between the carriages; by these alterations the interval of time required to put on the brakes, as shown in the above table, has since been reduced by nearly one-half, and an experiment recently made on the application of the brake in rear of a train of twenty-four vehicles on the Western Railway of France showed that the pressure commenced to be brought on in one second, and was fully on in two and a half seconds from the time of first moving the brake lever.

The importance of simultaneous action of the brakes in every part of a train arises from the fact that the train is not a rigid mass, but is made up of separate vehicles connected by means of spring draw-bars and buffers. The length of the train can thus be modified to a certain extent by the degree of compression of these springs. In a recent experiment on the North-Eastern Railway the train consisted of twenty-four carriages, and the whole extent to which the buffers could be compressed amounted to 35 feet. A train travelling at 60 miles an hour moves at 88 feet in a second. If the brakes act on the front part of the train before they affect the hind part the speed of the front carriages may be diminished by 10 to 18 feet in a second, whilst the hind part moves on with undiminished speed; thus the hind part may press against the front part with a force of from 12 to 20 foot tons for every ton weight of the hind vehicles. The buffer springs would be compressed by this force and remain so till the brakes acted equally on all the wheels, when a reaction of the buffer springs would take place; this reaction creates the violent jerks often felt with continuous brakes, and occasionally results in fractures of couplings and draw-bars. In a perfect brake the application would be instantaneous, and simultaneous on all the wheels of a train.

It is beyond the scope of this paper to enter fully into the merits of different kinds of brakes, but it may be convenient to sum up what seem to be the requirements of a perfect brake.

1. It should be fitted to act upon each wheel of the engine, tender, and every other vehicle in a train of any length. The brake-blocks, when out of action, must be kept a certain distance away from the wheels, in order to prevent any liability to drag against the wheels; and this distance, after being once adjusted, gradually increases by the wear of the blocks, and often exceeds three-quarters of an inch; while the springing of the brake-gear under great strain also adds to the extent of movement required in the brake force before the blocks are fully applied. Hence the brake gear should be so adjusted as to be capable of moving the brake blocks instantaneously through a space of one inch.

2. However brought into action, it should be capable of exerting upon the blocks of each pair of wheels, within two seconds, a force of twice, or at the very least one-and-three-quarter times, the load on those wheels.

3. The brake-block pressure acting on each wheel should be regulated so that the friction between the brake-block and the wheel may always be limited so as not to exceed the adhesion between the wheel and the rail; by which means it will produce the maximum effect at each moment of its application.

4. The brake-block pressure should be capable of being applied by engine-driver or by guards.

5. The engine, tender, and vehicles should each carry its own store of brake-power, which should be independent of the brake-power on any other vehicle.

6. The brake-block pressure should be automatically applied to every vehicle by the separation of the train into two or more parts, and it should also be applied by the act of the wheels of any carriage leaving the rails.

7. The brake-block pressure should be automatically applied by such failure of the connections or appliances as would render it afterwards incapable of application until the failure had been remedied.

8. The brake-block pressure should be capable of application with any degree of force up to the maximum, and it should be capable of continued action on inclines, or, of repeated applications at short intervals at junctions and stations.

In addition to these requirements, the questions of cost, durability, convenience in operation, and other essential points, will of course come under consideration.

The experiments which have been here described were made on trains travelling under conditions which were necessarily continually varying, both in respect of the condition of the rails and other matters; and they therefore contained many elements beyond the reach of calculation. It is hoped that some opportunity may arise, ere long, for resuming expeiiments on friction at high velocities under conditions whence these elements of disturbance may be eliminated. Meanwhile it is evident

that a continuous brake, capable of being applied simultaneously to every wheel of a train under the conditions which have been enumerated in this memorandum, is a much more practical and scientific method of bringing a train to rest than the old plan of concentrating the brake-power in two or three heavy brake vans placed in different parts of the train, and leaving the rest of the wheels without brakes.

The advantage which thus evidently ensues from utilising the adhesion of every wheel of a train for the purpose of stopping a train suggests the further consideration as to whether it would not be a more scientific arrangement, as well as more economical in regard to the permanent way of railways, to utilise the adhesion of every wheel of a train for causing the train to move forward, instead of depending for the moving force upon the adhesion of one heavy vehicle alone, viz., the locomotive. Experiments connected with the action of brakes on railway trains require very delicate apparatus; the credit of the design of the apparatus used in these experiments belongs to Mr. Westinghouse. The efficiency of the arrangements for making the experiments is due to the London, Brighton, and South Coast Railway Company, as represented by Mr. Knight, their general manager, who afforded every facility for the use of the line, and by Mr. Stroudley, the locomotive engineer of the Company.

DOUGLAS GALTON

OUR ASTRONOMICAL COLUMN

THE COMET OF 1532.—This comet, the second of the five observed by Apian, as described in his rare work, the "Astronomicum Cæsarium," has been the subject of much computation and discussion in connection with its long-assumed identity with the comet of 1661 observed by Hevelius, to which attention was directed by Halley when he published his "Synopsis of Cometary Astronomy." We read: "Halley was apt to believe that the comet of 1532 was the same with that observed by Hevelius in the beginning of 1661, but Apian's observations, which are the only ones we have, are too inaccurate to determine anything certain from them in so nice an affair." Pingré fully believed in the identity of the comets of 1532 and 1661, and in his "Cometographie" has endeavoured to point out several previous appearances of the same body, as in the year 1402, when he expresses his conviction that the great comet recorded in so many of the European chronicles about Easter was no other than the one in question. Between the perihelion passages of 1532 and 1661 is a period of 128¼ years, and so the return of the comet was long expected about 1789. Shortly before this year, however, the rediscussion of the observations of 1532 and 1661 was made the subject of a prize by the Paris Academy of Sciences, which was gained by Mechain.

His calculations threw much doubt upon the presumed identity of the comets, indeed were pretty generally considered as decisive against it. Olbers also recomputed the orbit from the observations of 1532, and although he found one much closer to that of the comet of 1661 than Mechain had done, seems to have arrived at the conclusion that the comets were not identical. Nevertheless, as the year 1789 approached, sweeping-ephemerides were prepared to facilitate a search, the then Astronomer-Royal, Dr. Maskelyne, taking a part in this work. The search was ineffectual, no one of the comets which appeared about that year presenting any indications of being the expected body.

It is probable that the elements of the comet of 1532 are open to even greater uncertainty than has been usually supposed. Apian's observations are clearly affected with large errors, yet we are under the necessity of relying upon them as the best data available, neither the vague and contradictory observations (if they deserve the name) by Fracastor at Verona, nor those of Vogelin at Vienna, being of service in the determination of a more certain orbit than can be inferred from the observations in the "Astronomicum Cæsarium." Apian appears to have observed at Dresden, and the times of observation are given by altitudes of Regulus and Arcturus; the amplitudes of the comet (S. to E.) and its altitudes are recorded. The positions of the stars for 1532·0 were:—

	Right Ascension.	Declination.
	° ′	° ′
Regulus	145 49·7	+14 12·1
Arcturus	208 35·2	+21 40·1

Assuming Apian's station to have been in longitude 0h. 54m. 56s. E. and latitude 51° 3′·7, his data furnish the following places, which, except for the first day, do not differ more than might have been expected from Pingré's reductions:—

	G.M.T.	Right Ascension.	Declination.
		° ′	° ′
1532, October	1·6635 ...	155 43·8 ...	−4 26·9
	2·6491 ...	160 10·7 ...	−3 20·3
	30·6699 ...	206 3·6 ...	+3 48·6
	31·6939 ...	208 48·3 ...	+4 20·6
November	7·6747 ...	218 51·1 ...	+5 55·8

We subjoin an orbit depending on the observations of October 2, 30, and November 7, and also Olbers' elements from Hindenburg's *Magazin für Mathematik*, 1787:—

	New Orbit.	Olbers.
Perihelion passage ...	Nov. 3·1355 G.M.T. ...	Oct. 18·3324
	° ′	° ′
Long. of perihelion	174 51	111 48
,, ascending node ...	132 32	87 23
Inclination	57 41	32 36
Perihelion distance	0·6736	0·5192
Motion	Direct.	Direct.

The comparison with the above-observed positions is slightly in favour of Olbers' orbit, though this differs from the place for November 7 by − 1° 40′ in longitude and − 4° 36′ in latitude. Still it will appear that Apian's observations may be represented within their evident limits of error, by orbits which differ widely.

The Chinese observed this comet from September 2 to December 25, according to the extracts from their annals which have been given by E. Biot and Williams: on the former date, according to Olbers' elements, the comet was in longitude 98°, latitude 47° south, distant from the earth 0·78, and on the latter date in longitude 249°, latitude 16° north, distant 2·13. The mention of the comet having traversed Cygnus probably applies to that of 1533; at any rate the comet of 1532 could not have passed through that constellation.

THE SUN'S PARALLAX.—Mr. David Gill, writing from Madeira, on his voyage to the Cape of Good Hope, to take the direction of the Royal Observatory, as successor to Mr. Stone, states in a communication to the Royal Astronomical Society, that the reduction of the observations of Mars, made during his expedition to Ascension, in 1877, have been so far completed that he is able to give the resulting solar parallax. He presents values, differing little *inter se*, deduced from various combinations of the observations and, as the definite figure, 8″·78, which being interpreted with the aid of Col. Clarke's last determination of the earth's equatorial semi-diameter, implies that the mean distance of the earth from the sun is 93,101,000 miles. This is a smaller parallax than perhaps was generally looked for, though not differing materially from several values which have been worked out recently.

METEOROLOGICAL REGISTERS[1]

THERE is now scarcely a meteorological observatory which is not provided with registering instruments. The number of these is already considerable,

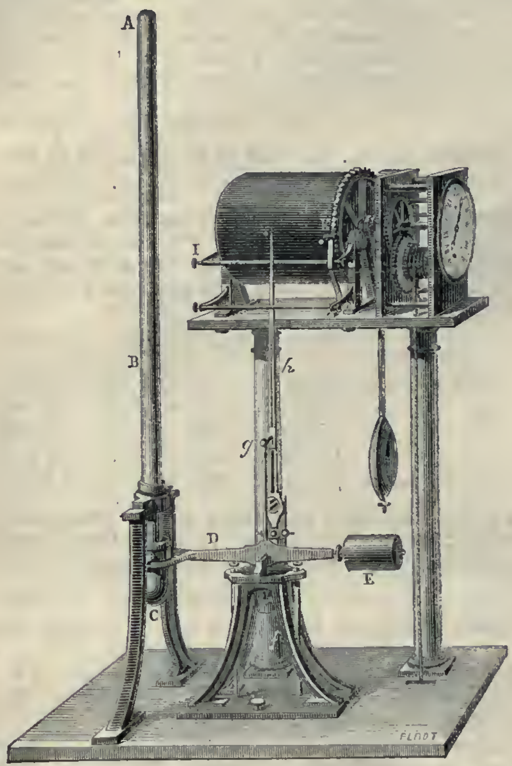


FIG. 1.—Registering Barometer.

and the methods of their construction are almost as numerous. At the observatory of Montsouris I have preferred continuous registration to registration by points, and the tracings effected by a fine metallic point on glazed paper blackened with smoke to the use of the pencil or to the *gaufrage* by pressure or by shock.

The barograph of Montsouris is a barometer-balance devised by P. Cecci, and latterly adopted by P. Secchi. The barometric tube A B (Fig. 1) is of iron, of 3 centimetres internal diameter, and of the same calibre throughout its length. It is fixed, and has, at its lower extremity, a cylindrical plunger, the full section of which is equal to the vacuum section of the barometric tube. The cistern, C, is of steel, and suspended to one end of the beam of a balance, D, the other end of which carries a counterpoise. The centre of gravity of the weighted beam coincides, as nearly as possible, with the central knife-edge, so as to render the equilibrium indifferent. Hence it results that when, in consequence of a rise of the barometer, a part of the mercury rises from the cistern into the tube, the former, thus rendered lighter, tends to rise, with the effect of introducing into the mercury of the cistern a greater length of the cylindrical plunger. Equilibrium is only re-established when (the volume of mercury displaced by the plunger being equal to that which corresponds in the tube to the increase in height of the barometric column) the level of mercury in the cistern returns to its constant point, and when, consequently, the apparent weight of that cistern has resumed its fixed value. The needle, *h*, of the beam of the balance marks its displacements on the surface of the blackened cylinder, K. It only remains to read the indications. To do this as accurately as possible, the support of the cylinder carries an electro-magnet, the armature of which is provided with an arm bearing a metallic point.[1] In ordinary weather this point is fixed, and traces on the cylinder a datum-line from which the ordinates of the barometric curve are measured; but every hour the electro-magnet is acted on by a clock marking the time on all the registers; the point departs momentarily from the line, and makes a clear stroke, which is reproduced at the same instant on the other cylinders. At the end of each week the cylinder is taken away, to be replaced by another kept ready, and is placed on the reading apparatus.

This apparatus (Fig. 2) consists of a horizontal steel bench, *f g*, provided on its upper surface with two columns, *h h'*, intended to support the axis of the cylinder, and on a vertical stand with two microscopes, which may be moved either separately or together in a horizontal direction. By means of an endless screw a movement of rotation on its axis may be communicated to the cylinder for the purpose of presenting successively to the microscopes the various faces of the cylinder. The microscope *b* is always pointed on the datum-line, and it is to follow this line in its accidental displacements, that the two microscopes may be moved together by the action of an adjusting screw. The microscope which points to the traced line carries at its focus two crossed threads, one horizontal and the other vertical. At each hourly reading one of the horizontal tracings on the datum-line is brought under the horizontal thread of the microscope. But, as the barometric curve often presents inflexions of which it is useful to note the exact time, the critical point of this curve being brought under the movable microscope *a*, a second horizontal thread, movable by a micrometric screw, serves to measure the distance of this point from the hourly mark immediately preceding.

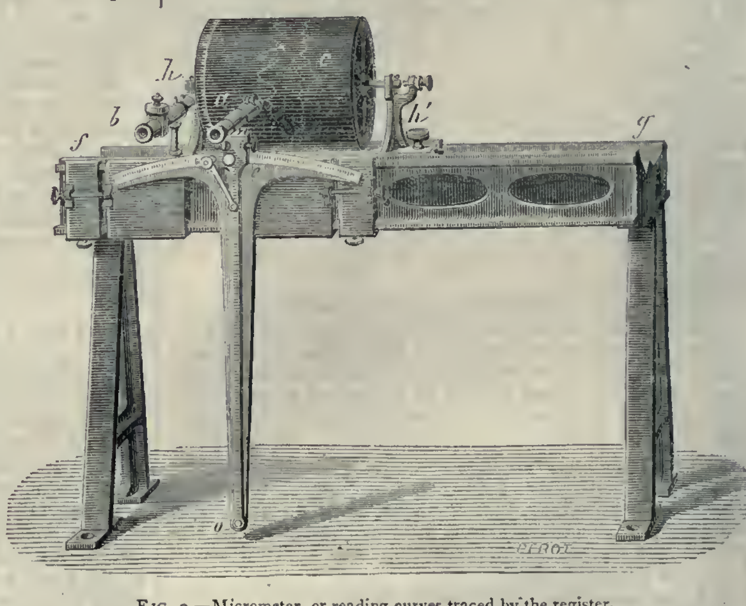


FIG. 2.—Micrometer or reading curves traced by the register.

The microscope *a* is supported at the extremity of an arm of a lever the length of which is equal to that of the

[1] Paper by M. Marié-Davy, *Journal de Physique*, April, 1879.

[1] This electro-magnet, which is seen in the thermograph (Fig. 3), is not shown in Fig. 1.

barometric needle; it describes, consequently, an arc of a circle of the same radius as the point of the register. This second microscope has a cross of threads like the first, but without a movable thread. The first microscope being pointed to an hourly sign, the axis of the second is directed to the corresponding point of the curve. The sine of the angle of position of its lever, multiplied by a

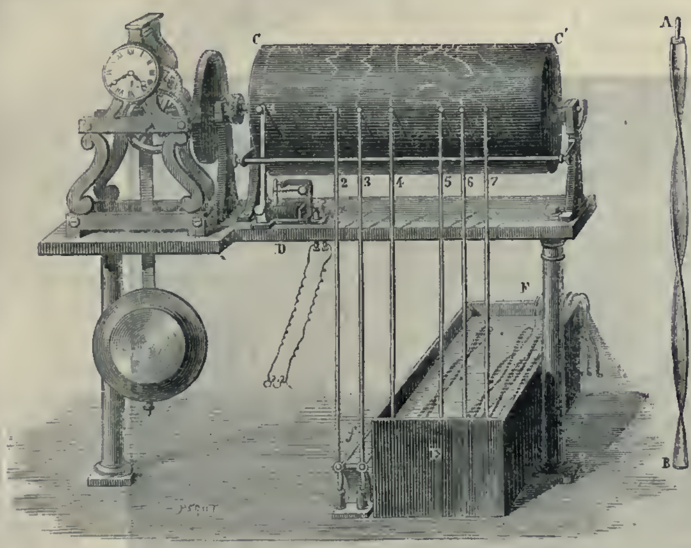


FIG. 3.—Thermograph.

constant factor and increased by a number equally constant, gives the height of the barometer at the moment selected. When the reading of the curve is made and verified, the sheet of blackened paper is taken off the cylinder and soaked in a weak solution of gum-lac or of copal in alcohol. By this means the smoked sheet is "fixed," and thereafter put in a portfolio.

The feeblest barometric variations are thus shown with

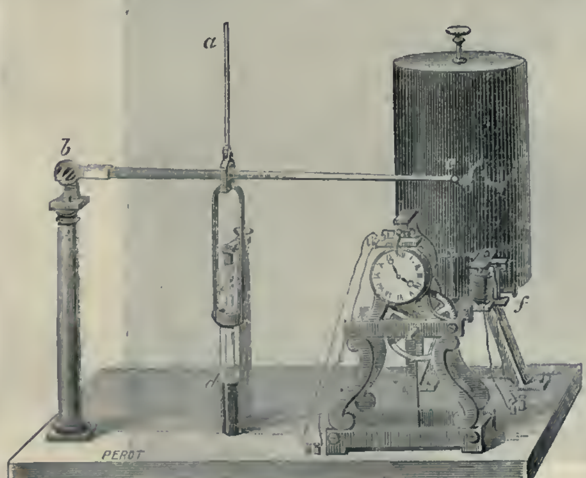


FIG. 4.—Register of the Atmograph.

great fidelity, and by examination of the curves we readily recognise the influence which the dynamical state of the atmosphere exercises in increasing or diminishing the weight of its pressure on the ground. It should be added that the uniformity of the calibre of the barometric tube annuls almost completely the action of temperature on the indications of the instrument.

The thermographs act in an analogous way, except that the motor is here formed by a Bourdon tube of hammer-hardened copper, with a very elongated elliptical section, and twisted into a sort of spiral, the thread of the spire varying from 2 to 3 centimetres, according to the purpose for which it is intended. A B (Fig. 3) represents one of these tubes, forming a little more than one spiral. This tube is exactly filled with alcohol, and closed at its two ends. The expansion of the alcohol compels it to untwist; but in order that its elasticity may be preserved, the internal pressure, corresponding to the highest temperatures to be reached, should not exceed 8 or 9 atmospheres. This pressure is all the greater in proportion as the thread of the spire is short. The twisted tube is fixed by one of its ends, the other free extremity bears the needle which gives the indications. At Montsouris this needle is 5 centimetres long, as is also that of the barometer. The process of reading the curves is thus exactly the same for all the needle registers. The new thermograph of Montsouris Observatory contains seven needles acting on the same cylinder. The first needle (No. 1, Fig. 3) belongs to the electro-magnet which traces the datum-line, and the hourly signs; needles 2 and 3 belong to the psychrometer; needles 4 and 5 record the temperature of the surface of ground exposed to the air without shelter; needles 6 and 7 correspond to the actinometer.

The psychrometer is formed of two twisted tubes placed outside on the north face of the wooden kiosk, which shelters the cylinder, and perpendicular to that face. Their furthest extremity is fixed, the other is prolonged through the wall of the kiosk by a stem of copper carrying the indicating needle. One of the twisted tubes is uncovered, and forms the dry thermometer; the other is covered with cambric, and kept moist by means of cotton-wicks dipped in small glass cups, connected with a Mariotte flask placed in the kiosk by means of a long and fine tube of caoutchouc. An instrument of this kind has been in use for fifteen months at Montsouris; its action is regular, and its sensibility very great.

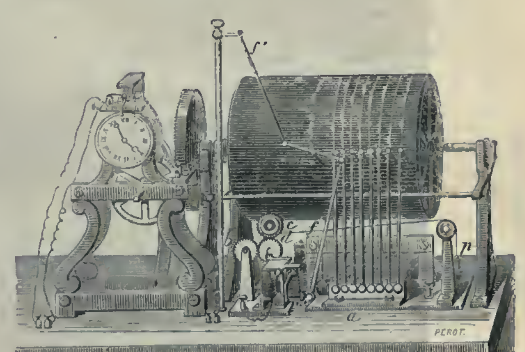


FIG. 5.—Anemograph.

The earth-thermometer is composed of two parts:—A thermometric reservoir of black copper is placed on the surface of a mass of vegetable mould, the top of which is flush with the platform of the roof of the kiosk; this reservoir communicates by a capillary tube of copper with a twisted tube placed in the kiosk under the cylinder of the register. When the temperature of the ground rises, a portion of the alcohol passes from the upper reservoir into the twisted tube, the pressure increases and the tube untwists; but the twisted tube itself and its capillary tube of

copper, are themselves acted on by the variable temperatures which complicate the results. A second twisted tube, similar to the first, provided with its capillary tube, serves to give the necessary corrections. The two twisted tubes are arranged parallel to each other in a trough, E F, filled with glycerinated water; the two capillary tubes are soldered to each other throughout their length. The two needles trace two curves, one very slightly sinuous, the other very undulating; the difference of their ordinates is measured. We thus obtain the temperatures of ground exposed to the sun during day, to nocturnal radiation during night, to rain and to evaporation.

The actinometer is also composed of two twisted tubes resting parallel to each other in the above-mentioned trough, E F, and of two capillary tubes. To each of these tubes corresponds a reservoir placed at the top of the roof of the kiosk, and inclosed in an envelope of glass on which a dry vacuum has been made. One of the reser-

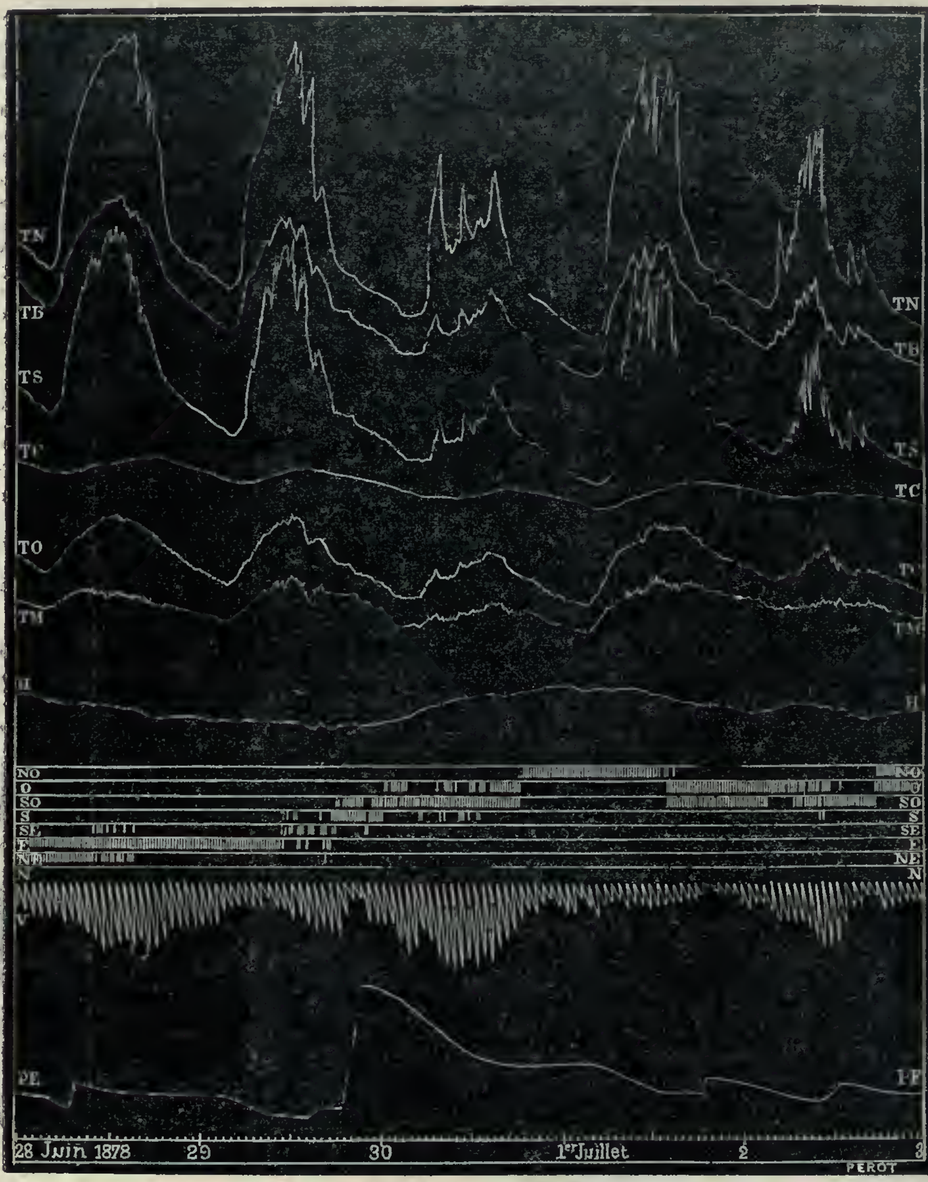


FIG. 6.—Specimen of curves made by the registers of Montsouris.

voirs is silvered, the other is blackened. Placed symmetrically at a little distance from each other, and far from any shelter, they give the same indications during the night; but during the day the black thermometer registers higher than the white one. The differences of the ordinates of the curves traced by the two needles serve to measure the actinic degree. Every cloud which passes over the sun gives rise to a rapid and considerable lowering of the temperatures of the white and black thermometers, and of that on the surface of the ground.

The atmograph is a third registering instrument intended to mark the variations of weight of a mass of earth whose surface is flush with the summit of the platform of the roof of the kiosk, and is exposed to the sun, to evaporation, rain, snow, and dew. At a little distance is the registering rain-gauge. The comparison of the

two curves shows what becomes of the water which falls on the naked earth, without vegetation, distinguishing between what returns to the atmosphere by evaporation, and what penetrates the subsoil which is permeable or drained. Another atmograph gives similar indications for a soil covered with various plants; but the latter being sheltered from the wind, ought to be moistened according as is necessary. Fig. 4 represents only the register of the atmograph. *a* is the lower part of the stem which is suspended to the extremity of the arm of the balance, in which is placed the mass of earth. A second lever arm, *b c*, follows and amplifies the movements of that stem which it inscribes on the vertical cylinder covered with paper blackened with smoke. This same stem bears a glass test-tube, *d*, containing mercury, in which is a fixed glass tube *e*. The diameter of this stem is so calculated that the point *c* traverses 100 millimetres for each millimetre of water gained or lost by the mass of earth. In calm weather we may thus appreciate the $\frac{2}{100}$th of a millimetre; but when the atmosphere is disturbed, the vertical components of the wind cause the needle to oscillate, thus interfering with the precision of the readings.

The anemograph (Fig. 5) gives us, at once, the direction of the wind and its mean rate per hour. Eight electro-magnets communicating electrically with the sectors arranged on the vane according to the eight principal points of the compass, can, by acting singly or two and two, record the winds for sixteen directions, which may be regarded to be sufficient for the wants of meteorology. A ninth electro-magnet is acted on each time that the Robinson drum shows a length of one kilometre traversed by the wind. The toothed wheel *b* then moves one division, and its movement is transmitted by the satellite wheel *d* to a third toothed wheel, *c*, on the axis of which is rolled a thread, *cp*. The point which marks the velocity then advances 1 mm. towards the left. This effect is produced during one hour for each kilometre traversed by the wind; but at the end of each hour the needle of the clock establishes an electric contact; the satellite wheel, *d*, is lowered; the wheel, *c*, becomes free; and the weight, *p*, restores the metallic point to its starting-place.

Fig. 6 presents a specimen of the curves traced by the registers from June 28 to July 3, 1878, reduced to one-third of their natural size. Beginning at the top, we find first the two curves, T N and T B, which together furnish the actinometric data; T N is the curve of the black thermometer, T B that of the silvered. The two following curves, T S and T C, give the temperature of the surface of the ground without shade; T S corresponds to the ground thermometer; T C gives the correction to be made in the ordinates of the first. The two curves, T O and T M, are those of the dry and wet thermometers; besides the temperature of the air in the shade, they give its hygrometric degree and the elastic force of its vapour. H is the curve of barometric pressure.

Underneath are eight straight lines corresponding to the eight principal directions of the wind; the vertical lines which rest on them indicate the directions in which the wind has blown. Further down are shown the velocity, V, of the wind in kilometres per hour.

The last curve, P E, is made by the atmometer; the increase in a vertical direction of this curve marks rain; the decrease marks evaporation. Notwithstanding the frequent and at one time very copious rains, the earth, on July 3, had very nearly resumed its weight of June 28. Finally, the last line is the datum-line on which the hours of the day are marked.

GERMAN PHYSIOLOGICAL CHEMISTRY[1]

As our general knowledge of nature increases, the possibility of individual knowledge decreases; the variety of discovery, the immense number of investigators, and the innumerable details which they accumulate in their respective branches of science, preclude the possibility of a modern "admirable Crichton." Werner's sigh, "True I know much, but yet I would know all," has been long acknowledged as an aspiration incapable of fulfilment, even supposing him to limit his desire of knowledge within the bounds of what is already known. To know "something of everything, and everything of something," is all that can be hoped for; day by day each science advances with such rapid strides, that one brain is incapable of grasping more than the general principles of one science; and any man who aims at enlarging the domain of science by fresh discovery, must content himself with confining his attention to a small corner, and by patient industry and indomitable perseverance seek to elicit some new facts.

[1] From Hoppe-Seyler's "Zeitschrift über physiologische Chemie."

Such, expressed in general terms, is the drift of the preface to Hoppe-Seyler's "Zeitschrift für physiologische Chemie." It seldom happens—unfortunately too seldom in this country—that medical men have more than a smattering of chemistry. A very low standard of chemistry is required for a medical degree, comprising a superficial knowledge of inorganic chemistry, chiefly of the non-metals; the merest smattering of organic chemistry, and ability sufficient to detect the acid and base in simple salts—such are the qualifications in chemistry necessary for graduation in medicine. When the student, following out the prescribed course, comes to attend lectures on physiology, and hears—almost always for the first time—the names of the various principles contained in the animal fluids, in the brain, in the liver, and in the muscular tissue, they fail to convey any definite idea to his mind, and he is utterly unable to comprehend, or even to form an idea of the reactions which take place in the animal organism. In Germany this state of things has been recognised in many universities, and special professors of physiological or animal chemistry have been appointed; these professors are not merely teachers, but are engaged in the active extension of their branch of science; and it is to facilitate the interchange of ideas between them, and to afford a medium in which the results of their investigations may be brought together, that Hoppe-Seyler has undertaken the editorship of this journal.

One noticeable feature of the investigations of German physiological chemists at present, is the attention devoted to ascertaining the changes which food undergoes in passing through the system. At least six memoirs on the subject are to be found in the nine published numbers of the journal, comprising the work of a year and a half. The methods and results of these experiments are worthy of a short description.

The food which we eat consists for the most part of carbon, hydrogen, and nitrogen; all food, however, does not contain nitrogen; starch, sugar, and fat are devoid of that element. The carbon and hydrogen, after being absorbed by the tissues, and performing work, are cast off as waste material, partly by the lungs, in the form of carbonic acid and water-vapour, and also, to a much smaller extent, in the urine. An almost inappreciable amount of nitrogen escapes by the lungs; by far the largest portion passes into the urine in combination with hydrogen and carbon, in the form of urea—a white crystalline body. Now this substance, urea, possesses a chemical, as well as a physiological interest. It was formerly supposed that all chemical compounds could be divided into two grand classes: inorganic bodies, such as could be prepared from purely mineral matter; and organic bodies, those existing only in a living organism, or obtained from these compounds by a process of decomposition. It was, therefore, imagined that an insurmountable barrier separated the two classes. Urea was ranked as an organic substance, for it had never been obtained except from the organism, till Prof. Wöhler, of

Göttingen, succeeded in preparing it from material of purely mineral origin. This process was to heat ammonium cyanate, $NH_4.CNO$, when, without decomposition, a new body was formed, possessing all the properties of, and undistinguishable from, urea. It has since been discovered that urea is very closely connected with the carbonates of ammonium, that, in fact, it is simply carbonate of ammonium minus water. Now it appears probable that urea is formed in the organism either from ammonium cyanate or from ammonium carbonate, and the question which Prof. Salowski, of Berlin, has tried to answer is: By which process is it formed? (vol. i. p. 1). As there is a general resemblance between all nitrogenous food, inasmuch as it contains albumen itself, or principles closely allied to albumen—among others, myosine, vitelline, serum-globuline (which form the subject of an article by Th. Weyl [vol. i. p. 72]); and moreover, as cyanic acid, carbonic acid, and ammonia, are products of decomposition of albumen, the question is an open one.

Every one knows the old plan of detecting the filcher of coin from a till, by placing a secret mark on a number of the coins, and so making their identity unmistakable. The plan adopted by Prof. Salowski is somewhat similar, though the simile is not quite applicable. There is a method of putting a private mark on cyanic acid and on ammonia, by using compounds containing more carbon in the former case, and by employing a substituted ammonia in the latter, that is, a substance possessing in the main the properties of ammonia, but capable of recognition afterwards. But as neither ammonia nor its salts are normal constituents of food, it was necessary to prove that by giving ammonia, a compound of nitrogen and hydrogen, along with food, the amount of urea in the urine is increased. Direct experiments on rabbits proved the point. After feeding them on a diet of potatoes containing a known amount of nitrogen, the amount of urea eliminated was augmented by addition of salts of ammonia to that diet. Now by introducing ammonia to form carbonate of ammonium, two atoms of nitrogen are introduced; and if that ammonia were "marked" the resulting urea would be "marked" also, and would contain two atoms of "marked" nitrogen. But, on the other hand, if the reaction takes place between cyanic acid (a body containing one atom of nitrogen itself) and ammonia, only one atom of nitrogen would be derived from the introduced ammonia, and if that ammonia could be afterwards identified, the urea into which it is resolved should contain only one atom of marked nitrogen.

In chemical language, let ethylamine be substituted for ammonia; in the first instance the equation should be—

$$C_2H_5NH_2 + HCNO = CO \left\{ \begin{array}{l} NH_2 \\ NH.C_2H_5 \end{array} \right. ;$$

and in the second—

$$CO(C_2H_5 . NH_2)_2 - 2H_2O = CO(NHC_2H_5)_2.$$

The former hypothesis was found to be true; only one nitrogen atom in the urea bore the mark, and the reaction is proved to take place by cyanic acid and ammonia combining, and then altering into urea, a body of the same composition but different properties, otherwise called an isomeride.

In spite, however, of this apparently convincing experiment, Prof. Salowski regards it as improbable that urea is actually formed by the reaction between ammonia and cyanic acid, unless, indeed, ammonia be supplied directly to the organism; he takes the view that under normal circumstances the urea is derived solely from cyanic acid assimilating water and evolving ammonia thus:—

$$2CNOH + H_2O = CO(NH_2)_2 + CO_2.$$

This would account for the increase of urea under a diet containing ammonia.

Dr. E. Baumann (vol. i. p. 60) contributes a paper announcing the discovery of phenol, or carbolic acid, in urine, and remarks that it is curious to observe a substance regarded as a preventive of fermentation generated, although in extremely small quantity, by fermentation. He also noticed the appearance of a nearly allied body, indicane, which, on allowing the urine to stand, changed into indigo, the well-known dye.

The colouring matter of the blood forms the subject of a series of contributions from the pen of the editor, Prof. Hoppe-Seyler (vol. i. pp. 121, ii. 149). Every one has noticed the fact that blood from an artery has a brighter red colour than that from a vein; the cause of this is that arterial blood is pumped by the heart from the lungs, where it has received a supply of oxygen from the air, into the arteries, which distribute it through the body. During its progress this oxygen is gradually used in oxidising waste matter and in converting the spent carbonaceous substances, which have fulfilled their purpose, into carbonic acid. The blood takes up this carbonic acid, and in doing so its colour becomes darker. The bright red principle of the blood is named oxyhæmoglobine, and after it has turned dark it has changed to hæmoglobine. Both of these substances can be separated from blood by appropriate processes. When placed in a tube and viewed through a spectroscope, oxyhæmoglobine exhibits two dark bands, whereas hæmoglobine shows only one band, occupying a position nearly between that of the two bands of oxyhæmoglobine, but slightly overlapping the one at the red end of the spectrum. These two substances can thus be easily distinguished from each other, and as the smallest trace of oxygen converts hæmoglobine into oxyhæmoglobine, the spectrum of which is easily recognised, even in presence of the other, a dilute solution of the former is a very delicate test for the presence of oxygen in liquids; so delicate, indeed, that one cubic millimeter of oxygen, or about as much as would occupy the space of a pin-head, can be detected.

It is of course evident that, as decay, and consequently removal of used-up material proceeds throughout the whole body, it is impossible to obtain blood, either wholly charged with oxygen or wholly free from it. Yet to be able to detect oxygen in such minute quantity, it is necessary to procure hæmoglobine absolutely free from oxygen. Hoppe-Seyler effects this by exposing the colouring-matter of blood to a putrefying medium; the small living organisms consume the oxygen that it contains, and reduce it to hæmoglobine. He remarks, *en passant*, that the colouring-matter of the blood withstands putrefaction perfectly, as well as the action of a special ferment found in the pancreas, which in this respect resembles bacteria, the living organisms in ordinary putrefying media.

This very delicate test for oxygen has been applied to various animal secretions. Saliva from the parotid and submaxillary glands, as might be expected from its proximity to external air, contains oxygen, but neither gall nor urine contain any, owing to the presence of easily oxidised substances named bilirubine and hydrobilirubine, by which any free oxygen is consumed.

It is not uncommon to hear of deaths caused by sleeping in an apartment in which there is a charcoal-stove. This is owing to the poisonous qualities of carbonic oxide gas produced by the combustion of the charcoal, and the effect is not improbably due to the formation of a compound between the hæmoglobine of the blood and the gas. Blood, when charged with carbonic oxide, acquires an almost vermilion-red colour. It also gives a characteristic spectrum, and its examination shows with certainty the cause of death. Hoppe-Seyler has noticed that, like oxyhæmoglobine, the compound of carbonic oxide with hæmoglobine is not destroyed by putrefaction, and hence blood taken from the veins long after death reveals the carbonic oxide spectrum, if death has resulted from charcoal-poisoning.

M. Dionys Szabó has made the character of the acid in gastric juice a subject of research (vol. i. p. 140), and has ascertained that it consists of both hydrochloric acid and lactic acid, analogous to that produced by the souring of milk. As hydrochloric acid is the more powerful corrosive and solvent agent, it is natural to expect it to be present in larger quantity than lactic acid in the stomach of the dog, which requires it to bring fragments of bone, &c., into solution. In certain dyspeptic cases hydrochloric acid is wanting, hence, probably, the dyspepsia, owing to lactic acid alone not being sufficient to bring the food into solution. It is probable that the lactic acid is produced from the albuminous constituents of food by oxidation, and that it acts on the salt which we take with our food, forming lactate of sodium, and liberating hydrochloric acid. Chemical decompositions of this nature, the converse of what happens in laboratory experiments, appear to be greatly favoured by dialysis through colloidal membranes, such as the walls of the ducts of the mucous membrane of the stomach.

Prof. Richard Maly (vol. i. p. 174) has made an attempt to explain the phenomenon of inverse chemical reactions, occurring under the influence of diffusion, with regard to the formation of hydrochloric acid. Prof. Graham, in his well-known researches on diffusion, showed that hydrochloric acid is the most diffusible of all liquids; that if a jar be filled with it, and carefully immersed in water, taking care not to mix the acid with the water, more hydrochloric acid escapes in a given time than is the case, under similar circumstances, with any other liquid. Now it is an ascertained fact that a weak acid can replace a strong one to a small extent, provided the weak acid is present in large quantity compared with the strong one. This replacement proceeds to a given point, when balance sets in, and the reaction goes no further, owing to the strong acid being liberated in such amount as to check any further decomposition, provided no disturbance takes place. But in the case of lactic and hydrochloric acids in the stomach, disturbance does take place, owing to the more rapid diffusibility of hydrochloric acid through the walls of the ducts. The hydrochloric acid is constantly being removed as it is formed, and the sodium chloride, or common salt, is continually in process of decomposition by the lactic acid. Hence the presence of hydrochloric acid in gastric juice. This decomposition is also effected by what is generally called "neutral sodium phosphate," which, although it has a faint alkaline reaction on litmus paper, yet, in a chemical point of view, is an acid substance, for it still contains hydrogen replaceable by a metal.

Dr. O. Lassar (vol. i. p. 165) contributes a paper on irrespirable gases. Every one who has visited a vitriol work knows the insufferable feeling of choking produced by the fumes of the evaporation-chamber, and even those who have not had that opportunity must occasionally have experienced the disagreeable sensation of breathing the fumes of burning sulphur from a sulphur match. This choking sensation seems not to be felt by animals; it is due to spasm in the glottis and involuntary contraction of the vocal chords. The object of Dr. Lassar's experiments was to ascertain whether such acid fumes are absorbed by the lungs, conveyed into the blood, and passed out by the urine. For this purpose he exposed rabbits and dogs to the dense fumes of sulphuric acid for more than an hour at a time, and examined the urine carefully for that acid. It was invariably absent, showing that the acid is not absorbed by the lungs. It was curious to remark that on exposure of an animal to nitric acid vapour of such strength that the hair, and even the membrane of the lungs, turned yellow, the animal did not suffer in health, and that the only effect of acid fumes in air is to diminish the proportion of oxygen. This explains what has often been wondered at—that workmen in the chlorine chambers and sulphuric acid evaporating-chambers are not injuriously affected by the acid fumes.

WILLIAM RAMSAY

GEOGRAPHICAL NOTES

THE special committee appointed by the International Meteorological Congress at Rome for the promotion of expeditions to the Arctic seas charged with making synchronous meteorological and magnetic observations, will meet at Hamburg on October 1 next, in order to arrange details and to discuss the means of arriving at the object aimed at. Preliminary steps in this direction have, as our readers are doubtless aware, been taken by Count Wilczek and Lieut. Weyprecht.

ON August 7 next a century will have elapsed since Karl Ritter, unquestionably the greatest geographer of his time, was born at Quedlinburg.

IN the last issue of the *Colonies and India* the attention of members of the Alpine Club is directed to the mountain peaks of the West Indies. In the Blue Mountains of Jamaica, for instance, views can be obtained which cannot be surpassed in the world. Many of these mountains have been, as yet, untrodden by the foot of man, and they offer a wide field to the student of natural history as well as the practical explorer. In the Island of Dominica, again, there are opportunities for exploring mountains which are hardly, if at all, known. An expedition under two Englishmen has lately scaled for the first time one of the peaks, known as Morne Trois Pitons, situated to the north of Roseau. The heights of these peaks are 4,528, 4,552, and 2,672 feet respectively. The foot of the centre *piton* was found to be at an elevation of about 1,800 feet. For a considerable distance the party were able to follow a wild-pig track, but they had to leave this and cut their way through dense vegetation and scrub. On reaching the summit they found it to be nearly flat, and covered with impenetrable vegetation. This curious plateau was estimated to be about ten acres in extent.

THE new number of the Belgian Geographical Society's *Bulletin* publishes reports from M. Cambier and Dr. Dutrieux on the march of the first Belgian African expedition from Mpwapwa to Tabora, in Unyanyembe. These are accompanied by a sketch-map of the country between the East Coast and Lake Tanganyika, on which the route of the expedition is laid down.

A GOOD harbour is stated to have been discovered near Point Parker, in the Gulf of Carpentaria, which will probably be of service in the development of that part of Australia.

THE Coreans are as little given to leaving their own country as the Japanese used to be, but we learn from a Shanghai contemporary that there appears to be a little colony of them forming in the neighbourhood of Chinkiang, for, in addition to the usual *ginseng* traders, there are now there several well-dressed Coreans having the appearance of the better class of officials. They wear slate-coloured garments as a sign of mourning for the Queen.

THE new number of *Le Globe* contains M. Veniukof's account of geographical work in Asiatic Russia during 1878, and a paper on the Sahara.

THE last *Bulletin* of the Société de Géographie Commerciale of Bordeaux has a long note on French establishments in India, which will be found useful in supplying information on a subject respecting which the world at large knows but little.

THE just published number of *Les Annales de l'Extrême Orient* contains the continuation of Dr. Harmand's notes on Khmer monuments, and of the Marquis de Croizier's essays on Indo-China, based on Dr. Bastian's investigations.

NOTES

PROF. TACCHINI has been appointed Director of the Central Office of Meteorology and of the Observatory of the Collegio Romano.

WE are requested to announce that during the months of August and September, the apartments of the Geological Society will be closed on Saturdays at 2 o'clock in the afternoon.

WE are glad to hear that there is a likelihood of the late Prof. Rankine's papers being republished in a collected form. Mr. W. J. Millar, of Glasgow, has been asked to act as editor, and is at present drawing np a list of papers which it might be advisable to reprint.

THE French Association for the Advancement of Science will hold its next session at Montpellier, as we announced some time ago. One of the two lectures will be on the "Electric Light," of which there will be a splendid display. The meeting of the Association will take place on August 28, so that the great heat will be no obstacle to the excursions, which will be attractive, as every effort will be made to take advantage of the exceptional position of the city. Montpellier being one of the oldest universities in the world, a number of historical relics will be exhibited for the first time to strangers, of high interest in the development of science.

THE meeting of the Swiss Association of Naturalists will take place at St. Gallen on August 10-12 next. The committee invites foreign naturalists to attend the meeting. The detailed programme may be had upon application to the secretary, Herr Stein, at St. Gallen.

DURING the last days of June shocks of earthquake of moderate intensity were felt on the south-east side of Mount Etna, particularly in the vicinity of the little town of Zafferana. The great crater at the time was sending forth a mighty thick black column of smoke. On the southern slope of the mountain the earthworks for the erection of the great astronomical observatory, for which Prof. Tacchini drew the plans, have been begun. The observatory will stand at an elevation of 3,000 metres above the sea; the largest telescope will measnre 33 centimetres in diameter. The Commission appointed by the Italian Government to study the phenomena accompanying the recent eruption, hav proposed the establishment of a Cabinet for Vulcanology, of which Prof. O. Silvestri is to be the director.

THREE violent shocks of earthquake occurred at Athens on July 3 at 4.15 P.M. The centre of the oscillations seems to have been at Xylokastron, near Corinth. On Mount Parnassus and at Thebes the phenomenon was also noticed. At Athens another shock was felt on the 6th shortly after midnight.

MR. W. LANT CARPENTER describes in the *Bristol Mercury* a visit he recently paid to Mr. Edison's laboratory at Menlo Park. The laboratory, workshops, &c., he states, as well as some isolated buildings for delicate electrical measurements, are spread over an acre of ground, railed in, admission to which is only given to privileged visitors. While waiting for Mr. Edison, Mr. Carpenter was conducted by a messenger through all the physical, chemical, and private experimenting laboratories, and then through the workshops, the machinery of which is driven by a beautiful, high-pressure, eighty-horse engine, also used to drive the electric-light machinery, most of which is in the same shop. About a dozen workmen were engaged, some in electrical test measnrements, &c., but chiefly in manufacturing Mr. Edison's latest form of telephone, constructed for the electric and hygrometric conditions of our English atmosphere. Mr. Edison admitted that he was not doing very much at present at the problem of domestic electric lighting. He appeared to consider the question of its economical subdivision a solved problem (he had sixteen lamps in the workshop, each with its small coil of platinum wire, in a glass globe, three to four inches diameter), and was now giving attention to the details of lamp construction. This new form of lamp is to be a minute cylinder of compressed pure zircon, a rare earth allied to magnesia, which is to be heated to whiteness by the surrounding coil of platinoiridium wire. A chemist was engaged in purifying zircon for this purpose. The newest thing in the shop was a dynamometer, the last and best of several invented by Mr. Edison, with the result of which he was perfectly satisfied, and he stated that with this instrument he had been able to show that, after deducting the necessary amount for friction in the machinery, more than 95 per cent. of the mechanical force employed was obtained in the form of light. Mr. Carpenter informs us that in consequence of a circular addressed by Mr. Edison to miners in Colorado (whence Mr. Carpenter has just returned) and elsewhere, platinum is being widely discovered in these districts, now attention is directed to it.

THE summer meeting of the Institution of Mechanical Engineers will be held in Glasgow, by the invitation of the Institution of Engineers and Shipbuilders in Scotland, commencing Tuesday, August 5. The following papers will be read and discussed:—"On the Pneumatic Marine Governor," by Mr. W. J. Dunlop, of Port Glasgow.—"On the 'Velometer' Governor," by Mr. F. W. Durham, of London.—"On the Maintenance of Constant Pressure in Water Service Pipes," by Mr. Stephen Alley, of Glasgow.—"On the Barton Water Regulator, or Reducing Valve," by Mr. W. H. Thomas, of London.—"On the Forging of Crank Shafts," by Mr. W. L. E. McLean, of Glasgow.—"On Water-pressure Engines with Variable Stroke," by Mr. John Hastie, of Greenock.—"On the Working of Traction Engines in India," by Mr. R. E. B. Crompton, of London.—"On the Construction and Working of a Vertical Action Steam Dredger," by Mr. R. B. Buckley, of the Public Works Department, Bengal.—"On Plate-rolling Machinery," by Mr. Edward Hutchinson, of Darlington.—"On Barton and West's Water Meter," by Mr. W. H. Thomas, of London. A number of interesting visits and excursions have been arranged.

WE are requested by the Committee of the Sunday Society to publish the following:—"Through the kindness of Sir Coutts Lindsay, the proprietor and director of the Grosvenor Gallery, the members of the Sunday Society have to-day (Sunday, July 27) been favoured with admission to the Summer Exhibition, between the hours of 6 and 8.30 P.M., and nearly 500 have availed themselves of the privilege. Next Sunday the Gallery will be opened to the public, free by tickets, which will be issued by the Society to all persons making written application and sending stamped and addressed envelope, for reply, to the Honorary Secretary, 19, Charing Cross, S.W. A special catalogue has been published by the Society, price 4*d.*; this must be obtained before Sunday, as no catalogues will then be on sale."

AN exhibition somewhat similar to the one we described at the Royal Aquarium, but on a larger scale, of plans, diagrams, models, apparatus, and all appliances illustrative of the various subjects that have to be considered in planning water-supplies, and the domestic arrangements for making them in the best way available, is to be held at the Alexandra Palace. The Exhibition will be arranged in fifteen section as follows:—Section I. Physics and Chemistry; Section II. Rainfall, &c.; Section III. Rivers; Section IV. Geology and Hydro-Geology; Section V. Waterworks; Section VI. Distribution of Water; Section VII. Statistics; Section VIII. Water Examination; Section IX. Filtration; Section X. Hardness; Section XI. Disease; Section XII. Antiquarian; Section XIII. Pollution; Section XIV.

Literature; Section XV. Few people really know anything of the various considerations that are involved in selecting and maintaining a "pure" and sufficient water-supply, and the spread of some of the knowledge that has been obtained may help to remove many of the prejudices against improvements, and may show that low water-rates are perhaps not the only points that ratepayers should regard. Sections X. and XI. especially refer to matters of general interest too often overlooked. It is hoped that a permanent museum, to be located somewhere in London, may result from this exhibition. All communications for the Committee should be made to Mr. A. T. Atchison, 34, Great George Street, S.W., and applications for space and for information respecting the exhibition should be made to Mr. W. H. Jones, Manager, Alexandra Palace, N.

THE new (German) Geological Society of Metz has just published its first *Jahresbericht* (for 1878). Apart from the usual report of proceedings at the meetings, the publication contain an interesting paper by Capt. Schultzen on the old Roman aqueduct from Gorze to Metz.

THE death from apoplexy is announced of M. Louis Favre, the contractor for the St. Gothard Tunnel. He was 53 years of age, and had engaged in nine years to construct a tunnel nearly 15 kilomètres long through beds of granite, gneiss, and serpentine. Notwithstanding difficulties of all kinds, the work had been carried on interruptedly for six years, the estimate being so careful that there was no excess of outlay, and M. Favre expected in two years to complete the work.

WE have received from Mr. E. Paterson, of Bedford Court, Covent Garden, parts i. and ii. of an unusually well got up illustrated Catalogue of Electrical Apparatus manufactured by him. Not only is the Catalogue itself exceedingly full and drawn up with much intelligence, but in the second part some really useful practical information is given on the principles and fixing of electric signals, which, we daresay, will be welcome to many. We are sure many of our readers will find Mr. Paterson's Catalogue of considerable service.

THE Americans have stolen a march upon us in sanitary matters, as they have done in so many other things. In March of this year an Act passed the U.S. Congress organising a Board of Health to look after all matters relating to the public health, and to advise Congress what steps should be taken for the promotion of so all-important a matter. We have just received the first number of the weekly *National Board of Health Bulletin*, published by this body, who have 50,000 dollars appropriated to them for salaries and expenses. Besides mortality statistics the *Bulletin* contains a number of rules and regulations with respect to the sanitary condition of ships.

M. COULON, conservator of the Industrial Museum of Rouen, has discovered a new system for transforming sound into light, which phenomenon has been the subject of a lecture at the Salle des Capucines by M. Frank Geraldy with the Gower telephone. Two Geissler tubes are put in quick rotation on an axis. The Ruhmkorf coil of the first is worked by an ordinary interruptor and gives the deviation of a luminous cross. The interruptor of the second is replaced by a telephone. The figure presented by the second tube projects on the first one, which is coloured by uranoxide glass and exhibits the most rapid changes according to the height of the note delivered in the telephone-trumpet. The sensibility of the changes are startling and most interesting. An exhaustive lecture by M. Coulon will be given at Rouen in a few days, and the apparatus exhibited at the Palais de l'Industrie.

DR. MOESTA has discovered the remains of an oak forest at a depth of 7 feet or 8 feet, near Rotenburg. The number of well-preserved trunks is enormous; one of them is 18 mètres long and 1 mètre and a half in diameter. This bog oak will be used for carving.

THE twenty-fourth meeting of German and Austrian Apiculturists will be held at Prague on September 7-11, and will be accompanied by an international exhibition of living bees, and all products and apparatus connected with bee-culture.

THE second Congress of Austrian wine-growers will be held at Vienna on September 22-25, and will be accompanied by an exhibition of all products, apparatus, and implements connected with viticulture.

AT Roveredo a statue has been erected to the eminent philosopher and statesman, Antonio di Rosmini-Sarbati (born 1797, died 1855). The work was executed by a Florentine sculptor, and the material is Carrara marble. The statue is said to be an excellent likeness.

PHYLLOXERA is unfortunately making rapid progress in Savoy. Since July 1 no less than forty-two different vineyards in the cantons of Chambéry, Montmelard, Yenne, and Rochette have been attacked by the pernicious insect; the head-centre of the infection seems to be at Chambéry and at Montmelard.

HERR KARL RUSS, the eminent German ornithologist, is writing a new work on foreign domestic birds, in three volumes. Two are completed and part of the third has recently appeared. Herr Karl Rümpler, of Hanover, is the publisher.

THE Central School Depot publishes a clearly written and instructive penny tract—"A Few Interesting Facts about Light, simply Told, for Young People," by the Rev. F. J. C. Fenton. Mr. Fenton discards all technical terms, and conveys a wonderful amount of accurate elementary information in a few pages.

A JAPAN paper says that there is a prospect of a new coal mine being worked in Ishigari, in the island of Yezo, the resources of which are only now beginning to be gradually developed. Some foreign experts in the employ of the Kaitakushi, or Colonisation Department, which is doing good work in Yezo, have tested specimens of coal and found them to be of good quality and suitable for purposes of steam navigation. As the locality where the coal exists is at some distance from the coast, it is proposed to construct a railway from it to the sea-board, and a survey of the country for that purpose is now being proceeded with.

FROM a recent investigation of the electric arc by Professors Thomson and Houston (*Journ. of Frank. Inst.*) it appears that the relations between arc resistance and current strength and between current strength and illuminating power, are expressed by the following laws:—(1) In arcs of equal lengths the resistances are inversely proportional to the current strengths; (2) The illuminating power of an arc is approximately proportional to the current traversing it; (3) In arcs of equal length the total energy given out is proportional to the current strength.

INTELLIGENCE has been received from Ceylon that the examination of supposed pearl-oyster banks on the east coast has not resulted in the discovery of any deposits worth fishing. The oysters found, though of the pearl kind, contained no pearls. It is supposed that they had been washed by currents from deep-sea banks in the Bay of Bengal.

UNDER date of April 30, a correspondent of the *North China Herald* at Wladivostock, in Russian Manchuria, writes that, although the mountain tops were still covered with snow, the winter had at length come to an end, the ice in the harbour having on that day broken up and floated out to sea. The winter began in October and has been the severest known for many years. The bay was entirely covered with ice from two to three feet thick. Wladivostock is said to be improving, though slowly, and there are signs of an attempt at road-making.

THE *Japan Gazette* learns that as an encouragement to the producers of tea, silk, and cocoons, it has been resolved by the Government to hold an exhibition of these articles in the Machigwai-sho at Yokohama. Foreigners and native dealers are not to be allowed to exhibit, as the scheme is devised entirely for the benefit of producers and manufacturers.

GOLD-BEARING quartz has lately been discovered at Sarugoye in the Yamato district of Japan.

THE *Golos* reports the discovery in the district of Perejaslavl, Pultowa Government, of 370 flint arrow-heads, a number of bones of men and animals, fragments of earthenware, and bronze objects.

THE *Annual Report* of the Goole Scientific Society for 1878-9 records satisfactory progress. As the result of a rule admitting ladies, twenty-one have joined the society.

THE Hull Literary and Philosophical Society, to judge from the Report for 1878-9, seems to be doing a great variety of good work in their district by means of lectures, papers, classes, &c. The Society is in a flourishing condition as to members and funds, and has added, during the session, a Microscopical and a Geological Section.

THE additions to the Zoological Society's Gardens during the past week include two Red and Yellow Macaws (*Ara chloroptera*), a Red and Blue Macaw (*Ara macao*), a Blue and Yellow Macaw (*Ara ararauna*) from South America, a Common Trumpeter (*Psophia crepitans*) from Demerara, presented by Mr. Chas. Fricker; two Golden Eagles (*Aquila chrysaëtos*) from Scotland, presented by Mrs. A. H. Browne; a Geoffroy's Marmoset (*Midas geoffroii*) from Panama, purchased; a Stanley Crane (*Tetrapteryx paradisea*) from South Africa, received in exchange; a Bay Antelope (*Cephalophus dorsalis*) from West Africa, deposited; a Peacock Pheasant (*Polyplectron chinquis*), two Black-crested Cardinals (*Gubernatrix cristatella*), two Geoffroy's Doves (*Peristera geoffroii*), bred in the Gardens.

THE EOZÖON CANADENSE

WE have received the following communications on this subject:—

I shall be glad to be allowed to ask your readers to suspend their judgment in the matter of *Eozöon*, until the appearance of the *full and complete memoir*, based (I venture to say) upon investigations far more comprehensive than those of Prof. Moebius—upon which I am now engaged, in conjunction with my friend Prof. Dawson. But as the production of this memoir will necessarily be a work of considerable time, on account of the elaborate illustrations it will require, I would now offer the following brief remarks on that part of Prof. Moebius's discussion which relates to the so-called "canal-system."

Among the numerous beautiful figures which Prof. Moebius has given of *sections* of the "canal-system," there is not one which represents what I described and figured, when I last wrote on the subject (*Ann. of Nat. Hist.*, June, 1874, plate xix.), as "what appears to be the typical mode of its distribution." Nor is this brought out in any of the small number of figures which Prof. Moebius gives of the *internal casts* obtained by decalcification. Now to any one who will picture to himself how imperfect would be any conception he could form of the ramification of a *tree*, by taking a number of sections of its stem and system of branches through different planes, it must be obvious that "internal casts," in relief, when well preserved, will give a representation of the canal-system, which must be much truer than any conception can be that is based on a comparison of sections only; and that, in fact, it is only when the sections are interpreted by such solid models, that the real forms and relations of these "canal-systems" can be made out.

Having been kindly furnished by Prof. Dawson some months ago, with a large amount of new material, consisting of numerous specimens of *Eozöon*, obtained from different localities and in different states of mineralisation, I am now able to assert with confidence that the peculiar distribution described and figured by me from the actual specimens (one of which has been in Prof. Moebius's own possession) five years ago,[1] is the *regular and characteristic "canal-system" of Eozöon*. For my cabinet now contains *hundreds* of examples of it, both in transparent sections and in the solid models obtained by decalcification; and these last, in partially "dolomitised" specimens of *Eozöon*, show the following singular peculiarities, which do not seem to have fallen under Prof. Moebius's observation. When a band of dolomite runs through the calcite layers, (1) the "canal systems" in its neighbourhood are very commonly filled with *dolomite*, instead of with serpentine; (2) in one and the same canal-system, some of the branches are often filled with dolomite, and others with serpentine; while (3) individual branches are often partly filled with one mineral and partly with the other.

How these facts can be explained, except by the *pre-existence of a system of canals in the calcareous layers* into which these minerals have penetrated, I must confess myself unable to conceive; and that they thus afford demonstrative evidence of a structure which cannot be otherwise than *organic* is not merely my own opinion, but that of such accomplished petrologists as Prof. Geikie, who has been for some years engaged in the microscopic study of the metamorphic rocks of Scotland, and Prof. Bonney, who has been similarly studying the Cornish serpentines.

Whether, when taken in connection with the general structure of the organism, these "canal-systems" indicate its *Foraminiferal* affinities is, of course, an altogether different matter. To Prof. Moebius the difference seems greater than the resemblance; but it is noteworthy that his comparisons are limited to types examined by himself, and do not extend to *Calcarina*, in whose "canal-system" Dr. Dawson and I recognise the nearest approach to that of *Eozoön*. To myself, as to the late Prof. Max Schultze,[2] the resemblance seems greater than the difference. And as the several "canal-systems" of *Nummulina*, *Polystomella*, *Calcarina*, *Tinoporus*, and *Cycloclypeus* (all originally worked out by myself) *differ from each other* in plan, I cannot regard it as a valid argument *against* the foraminiferal affinities of *Eozöon* that its canal-system has a plan of its own. Surely Prof. Moebius would not deny the foraminiferal characters to any new *recent type* that the *Challenger* or any other collection may yield, if it should show a plan of canal-system different from any yet known, and approximating to that of *Eozöon*.

That in its *general plan of growth* (to which the distribution of the canal-system is intimately related) *Eozöon* differs from all recent *Foraminifera* at present known cannot be regarded as a proof of its *non*-foraminiferal character by any who have fully studied the very wide range of forms which that group comprehends, including the numerous indefinite "arenaceous" types, whose import is only now beginning to be understood by those who have the best opportunities of studying them.

I would suggest this further consideration: If we are to relegate to the mineral kingdom every supposed fossil that does not conform to any known existing type, we must expunge not only *Eozöon*, but *Stromatopora*—to say nothing of many other fossils whose place no one has yet been able to assign with certainty. Now, is Prof. Moebius prepared to say that *Stromatopora* is a "pseudomorph," because one zoologist thinks it a coral, another a sponge, and another a foraminifer? On his method of "differences" it is clearly neither one of these; and must, as he says of *Eozöon*, be either shut out of the animal kingdom altogether, or be made to constitute a sub-kingdom in itself. To myself it appears more philosophical to suppose that such "archaic" types combined in themselves characters which were afterwards specialised as those of distinct groups. And following this clue, I find in the chambered structure of *Eozöon*, and in its general relations to the canal-system traversing its calcareous layers, points of essential conformity to the group of *Foraminifera*, which seem to me far to outweigh the differences of detail by which Prof. Moebius has been led to the opposite conclusion.

I limit myself to this special point, because an excellent general criticism of Prof. Moebius's memoir, from the pen of Dr. Dawson, has already appeared in the *American Journal of Science*; and I hope that as you have given so much prominence to the views put forth by Prof. Moebius, you will do Dr. Dawson

[1] I think it rather hard that an *early diagram* of mine should be cited, and made the subject of adverse criticism, while those more recent *representations of actual structures* are ignored.

[2] I have been informed on good authority that Prof. Max Schultze left behind him for publication an elaborate and beautifully illustrated memoir on *Eozöon*, arguing for its foraminiferal character on account of the *resemblance* of its "canal-system" to that of existing types.

and myself the justice of placing before your readers his statement of objections to them, in which I fully concur.

Hereafter I think I shall be able to show that the "cumulative argument in favour of the organic character of *Eozöon* is as strong as that of the human origin of the "flint implements." Any one of the fractures that has given to these their characteristic forms, *might* have been accidental; and yet it is impossible to conceive that any number of such flints can have been so shaped "by accident." WILLIAM B. CARPENTER

London, July 28

The following is the communication from Principal Dawson referred to by Dr. Carpenter:—

Eozöon canadense has, since the first announcement of its discovery by Logan in 1859, attracted much attention, and has been very thoroughly investigated and discussed, and at present its organic character is generally admitted. Still its claims are ever and anon disputed, and as fast as one opponent is disposed of another appears. This is in great part due to the fact that so few scientific men are in a position fully to appreciate the evidence respecting it. Geologists and mineralogists look upon it with suspicion, partly on account of the great age and crystalline structure of the rocks in which it occurs, partly because it is associated with the protean and disputed mineral serpentine, which some regard as eruptive, some as metamorphic, some as pseudomorphic, while few have had enough experience to enable them to understand the difference between those serpentines which occur in limestones, and in such relations as to prove their contemporaneous deposition, and those which may have resulted from the hydration of olivine or similar changes. Only a few also have learned that *Eozöon* is only sometimes associated with serpentine, but that it occurs also mineralised with loganite, pyroxene, dolomite, or even earthy limestone, though the serpentinous specimens have attracted the most attention, owing to their beauty and abundance in certain localities. The biologists on the other hand, even those who are somewhat familiar with foraminiferal organisms, are little acquainted with the appearance of these when mineralised with silicates, traversed with minute mineral veins, faulted, crushed, and partly defaced, as is the case with most specimens of *Eozöon*. Nor are they willing to admit the possibility that these ancient organisms may have presented a much more generalised and less definite structure than their modern successors. Worse, perhaps, than all these, is the circumstance that dealers and injudicious amateurs have intervened, and have circulated specimens of *Eozöon*, in which the structure is too imperfectly preserved to admit of its recognition, or even mere fragments of serpentinous limestone, without any structure whatever. I have seen in the collections of dealers, and even in public museums, specimens labelled "*Eozöon canadense*" which have as little claim to that designation as a chip of limestone has to be called a coral or a crinoid.

The memoir of Prof. Moebius affords illustrations of some of these difficulties in the study of *Eozöon*. Prof. Moebius is a zoologist, a good microscopist, fairly acquainted with modern foraminifera, and a conscientious observer; but he has had no means of knowing the geological relations and mode of occurrence of *Eozöon*, and he has had access merely to a limited number of specimens mineralised with serpentine. These he has elaborately studied, and has made careful drawings of portions of their structures, and has described these with some degree of accuracy; and his memoir has been profusely illustrated with figures on a large scale. This, and the fact of the memoir appearing where it does, convey the impression of an exhaustive study of the subject, and since the conclusion is adverse to the organic character of *Eozöon*, this paper may be expected, in the opinion of many not fully acquainted with the evidence, to be regarded as a final decision against its animal nature. Yet, however commendable the researches of Moebius may be, when viewed as the studies of a naturalist desirous of satisfying himself on the evidence of the material he may have at command, they furnish only another illustration of partial and imperfect investigation, quite unreliable as a verdict on the questions in hand. The following considerations will serve to indicate the weak points of the memoir:—

1. A number of errors and omissions arise from want of study of the fossil *in situ*, and from want of acquaintance with its various states of preservation. Trivial errors of this kind are his referring to my photograph in Plate III. of the "Dawn of Life," as if it were natural size, and his stating that the larger specimens have fifty laminæ, whereas they often have more than a hundred. More important is his failing to appreciate aright the occurrence of *Eozöon* in certain layers of regularly bedded limestones, the rounded or club-shaped forms of the more perfect specimens, the manner in which the layers become confluent at the edges of the forms, as described by Sir W. E. Logan and myself, or the amount of crushing and fracture which most of the specimens exhibit. Thus he fails to convey any adequate idea of the Stromatoporoid forms and mode of occurrence of the organism, or indeed of its general character and probable mode of growth. Further, he treats it from the first as a mere laminated aggregate of calcite and serpentine, without reference to its occurrence in any other state, and also without reference to the fragmental limestones in part made up of its remains. He objects strongly to the want of definiteness of form and distribution in the chambers and connecting passages, without making allowance for defects of preservation, or mentioning the similar want of defined form in some *Stromatoporæ*. He admits, however, that the modern *Carpenteria* and its allies are in some respects equally indefinite. He further objects to the impossibility of detecting regular primary chambers like those in modern foraminifera, but seems not to be aware that, as I have recently shown, some *Stromatoporæ* originate in a vesicular, irregular mass of cells, and that in *Loftusia*, both the eocene *L. Persica* and the carboniferous *L. Columbiana*, the primary chamber is represented by a merely cancellated nucleus.[1]

2. With reference to the finely tubulated proper wall of *Eozöon*, he has fallen into an error scarcely excusable in an observer of his experience, except on the plea of insufficient access to specimens. He confounds the proper wall with the chrysotile veins traversing many of the specimens, and obviously more recent than the bodies whose fissures they fill. That he does so is apparent from his stating that the proper wall structure sometimes crosses the bands of serpentine and calcite, and also that it presents a series of parallel four-sided prisms, whereas, when at all perfectly preserved, it shows a series of cylindrical threads penetrating a calcite wall. That some of his specimens have contained the proper wall fairly preserved is obvious from his own figures, in which it is possible to recognise both this structure and chrysotile veins, though confounded by him under the same designation. He objects, somewhat naïvely, that many of the chambers fail to exhibit this nummuline wall, and that it sometimes presents a ragged appearance or is altogether opaque. In point of fact it can appear distinctly, either in decalcified specimens or in slices, only when the minute tubes are filled with some substance optically distinguishable from calcite, or not acted on by dilute acid. When the proper wall is merely calcareous (and I have specimens showing that it is often in this state, and without any serpentine in its pores), its structure is ordinarily invisible, and it is the same when the calcareous skeleton has from any cause lost its transparency or has been replaced by some other mineral substance. Even in thickish slices, the tubes, though filled with serpentine, may be so piled on one another as to be indistinct. All this may be seen in tertiary *Nummulites*. When wholly calcareous their tubulation is often quite invisible, and when imperfectly injected with glauconite or other silicates, they often present a very irregular appearance. If Prof. Moebius will study the Nummulites injected with glauconite from Kempten,[2] Bavaria, in addition to the casts of *Polystomella* from the Ægean, to which he refers, he will be better able to appreciate these points. It may be worth repeating here that, in examining the original specimens of *Eozöon*, I did not recognise the proper wall. I did not doubt that it must have existed in some form, since I could easily detect the canals in the supplemental skeleton; but I did not wonder at its non-appearance, knowing the chances against its preservation in a recognisable form. Its discovery was due to the subsequent investigations of Dr. Carpenter.[3]

3. To the canal system, Prof. Moebius does more justice and admits its great resemblance to the forms of this structure, in modern *Foraminifera*. This indeed appears from his own figures, which well show how wonderfully this structure has

[1] See *Journal* of London Geol. Soc., January, 1878.

[2] I am indebted to Mr. Otto Hahn for specimens of these most interesting fossils.

[3] It may deserve mention here that the carboniferous *Fusulina* very rarely shows it tubulated wall, and that Dr. Carpenter had maintained its Nummuline affinities before he obtained specimens showing this particular structure. Structures so delicate as these are indeed only preserved exceptionally in fossil specimens.

been preserved, and how nearly it resembles the similar parts of modern *Foraminifera*. He thinks, however, that these round and regularly branching forms are rather exceptional, which is a mistake; though it is true that the sections of the larger canals are often somewhat flattened, and that they become flat where they branch. They are also sometimes altered by the vicinity of veinlets or fractures, or by minute mineral segregations in the surrounding calcite, accidents to which all similar structures in fossils are liable. Another objection, not original with him, is derived from their unequal dimensions. It is true that they are very unequal in size, but there is some definiteness about this. They are larger in the thicker and earlier formed layers, smaller or even wanting in the thinner and more superficial. In some slices the thicker trunks only are preserved, the slender branches having been filled with dolomite or calcite. It is difficult, also, to obtain, in any slice or any surface, the whole of a group of canals,[1] Further, as I have shown, the thick canals sometimes give off groups of very minute tubes from their sides, so that the coarser and finer canals appear intermixed. These appearances are by no means at variance with what we know in other organic structures. Another objection is taken to the direction of the canals, as not being transverse to the laminæ but oblique. This, however, may be dismissed, since Moebius has of course to admit that it is not unusual in modern *Foraminifera*. It may be added that some of the appearances which puzzled Moebius, and which are represented in his figures, evidently arise from fractures displacing parts of groups of canals, and from the apparently sudden truncation of these at points where the serpentine filling gives place to calcite. It would also have been well if he had studied the canal systems of those *Stromatoporæ* which have a secondary or supplemental skeleton, as *Cœnostroma* and *Caunopora*.

4. A fatal defect in the mode of treatment pursued by Moebius is that he regards each of the structures separately, and does not sufficiently consider their cumulative force when taken together. In this aspect, the ease of *Eozöon* may be presented thus: (1) It occurs in certain layers of widely distributed limestones, evidently of aqueous origin, and on other grounds presumably organic. (2) Its general form, lamination, and chambers, resemble those of the silurian *Stromatopora* and its allies, and of such modern sessile foraminifera as *Carpenteria* and *Polytrema*. (3) It shows under the microscope a tubulated proper wall similar to that of the Nummulites, though of even finer texture. (4) It shows also in the thicker layers a secondary or supplemental skeleton with canals. (5) These forms appear more or less perfectly in specimens mineralised with very different substances. (6) The structures of *Eozöon* are of such generalised character as might be expected in a very early Protozoan. (7) It has been found in various parts of the world under very similar forms, and in beds approximately of the same geological horizon. (8) It may be added, though perhaps not as an argument, that the discovery of *Eozöon* affords a rational mode of explaining the immense development of limestones in the Laurentian age; and on the other hand that the various attempts which have been made to account for the structures of *Eozöon* on other hypotheses than that of organic origin have not been satisfactory to chemists or mineralogists, as Dr. Hunt has very well shown.

Prof. Moebius, in summing up the evidence, hints that Dr. Carpenter and myself have leaned to a subjective treatment of *Eozöon*, representing its structure in a somewhat idealised manner. In answer to this it is necessary only to say that we have given photographs, nature-prints, and camera-tracings of specimens actually in our possession. We have not thought it desirable to figure the most imperfect or badly preserved specimens, though we have taken pains to explain the nature and causes of such defects. Of course, when attempts at restoration have been made, these must be taken as to some extent conjectural; but so far as these have been attempted they have consisted merely in the effort to eliminate the accidental conditions of fossilised bodies, and to present the organism in its original perfection. Such restorations are not to be taken as evidence, but only as illustrations to enable the facts to be more easily understood. It is to be observed, however, that in the study of such fossils as *Eozöon*, the observer must expect that only a small proportion of his specimens will show the structures with any approach to perfection, and that comparison of many specimens prepared in different ways may be necessary in order to understand any particular feature. A single figure or a short description may thus represent the results of days spent in the field in collecting, of careful examination and selection of the specimens, of the cutting of many slices in different directions, and of much study of these with different powers and modes of illumination. My own collection contains hundreds of preparations of *Eozöon*, each of which represents perhaps hours of labour and study, and each of which throws some light more or less important on some feature of structure. The results of labour of this kind are unfortunately very liable to be regarded as subjective rather than objective by those who arrive at conclusions in easier ways.

Taken with the above cautions and explanations, the memoir of Prof. Moebius may be regarded as an interesting and useful illustration of the structures of *Eozöon*, though from a point of view somewhat too limited to be wholly satisfactory.

[1] I have succeeded best in this by etching the surface of broken specimens.

THE COLOURS OF DOUBLE STARS

IN a recent number of the *Bulletin de l'Académie royale de Belgique*, M. Niesten, of the Brussels Observatory, has published some interesting details relating to the colours of double stars, to which subject he has given special attention for a considerable time past. When comparing the periodicity of solar spots with the longitudes of planets in the ecliptic, Messrs. De la Rue, Balfour Stewart, and Loewy had found that a distinct connection exists between solar activity and the relative positions of the different members of our planetary system. A long time ago the attention of astronomers had already been drawn to the fact that Wolf's sun-spot period of eleven years coincides with the period of Jupiter's revolution round the sun. Later on Prof. Balfour Stewart pointed out that the coincidence of the perihelia of Jupiter and Saturn, which occurs about every fifty-nine years, corresponds to another one of Wolf's spot-periods.

If, therefore, the relative positions of the planets with regard to the sun have some influence upon the activity of that luminary, the question is justifiable whether on the other hand the influence of the sun upon the planets might not be apparent through some slight changes in their colour. There is no doubt that the colours of the planets actually do change; their brightness increases and decreases according to their position near the perihelion or aphelion. In the case of Jupiter changes of colour have been repeatedly observed, and they seem to coincide with the sun-spot periods. At the last opposition of Mars, when the planet was near its perihelion, it seemed to be less ruddy than usual; Uranus, which was generally described as shining with pale bluish light, is now, when it is approaching its perihelion, remarkable by its bright white lustre.

These relations between the sun and the planets induced M. Niesten to search for similar relations among the double stars, and specially to try to answer the question whether the changes of colour which have taken place in several double-star systems are in any way connected with the relative position of the components of a double star. For this purpose he collected the observations of astronomers who have given special attention to the colours of stars, and catalogued the colours of the stars visible in our horizon. It was found that many double-stars have not changed in colour since they were first observed, while others in a period of more or less considerable duration have shown a series of changes of colour, which seem to follow a definite law. The changes of colour were particularly remarkable in those double stars which possess great velocity of revolution. M. Niesten gives a table in which the different colours of twenty double stars of known period and periastrium, *i.e.*, the colours of the principal star and of the companion, as observed at different periods, are compiled. From M. Niesten's discussion of the facts revealed by this table, we will give that relating to the first two double-star systems by way of example.

In 70 *p* Ophiuchi, the period of revolution of which is 94·37 years, and for which the periastrium occurred in 1807, the colour of the principal star at Herschel's time (an epoch closely preceding the periastrium) was white; the star then changed in colour, passing from white, through yellow and pale topaz-coloured to golden yellow, reaching this tint about 1854. From this period it showed a tendency to return to white, passing through yellow and pale yellow. In 1877 Mr. Pritchard designated it as pale yellow, and afterwards as white. The companion during its revolution showed similar fluctuations of colour to those of the principal star. In the vicinity of the periastrium Herschel put it down as reddish (we must remember here that Herschel's

speculum gave a slight reddish tint to all objects); now the companion is bluish white, and between these two epochs it showed more saturated colours.

The short period of ζ Herculis (34·32 years) allows us to consider the changes of colours during two revolutions. Herschel measured this system about the epoch when the companion was very near to the primary; the latter was white, the former ash-coloured. At the periastrium of 1860 Mr. Knott saw them pale yellow and greenish respectively; at other epochs the colours of the two components are all the more marked the further they are away from the periastrium, the companion always showing warmer tints than the principal star. About the epoch of the apparent periastrium M. Dembowsky designated them as yellow and olive colonred. Similar phenomena are shown by the other donble stars given in the table, all of which are systems with closed, *i.e.*, elliptical orbits. In the double star 61 Cygni, where no closed orbit has been observed, but where the small companion moves in a straight line relatively to the larger one, the same yellow tint has been observed from 1828 to 1873.

In the cases of optical double-star systems, *i.e.*, those which only accidentally happen to be in the same line of sight, and which show a rectilinear motion, the principal star is generally yellow and the companion blue. In Mr. Brothers' catalogue, which comprises 105 double-star systems, with closed orbits, there are only thirty-two where the companion is blue, while all the others show the same colour as the principal star. And even these thirty-two systems may possibly be optical ones, in which the companion is almost exclusively blue. The absence of blue in the companions of double stars of short period is most remarkable.

The blue colour of the companions in the optical systems is not an effect of contrast to the yellow colour of the primaries, for the former are blue even if the latter are shut out of the field of vision. It seems possible that, similar to the effect in our atmosphere, where distant objects assume a bluish tint, celestial bodies which send us their rays of light from the most distant regions, may appear blue on account of the thickness of the medium through which the light passes.

M. Niesten has compiled a table of double stars with blue companions, and has arranged them according to their position in declination and right ascension. From this it appears that these double stars are principally situated in a zone extending from decl. 10° S. to 40° N., and further that there are two maxima of occurrence, one in R.A., 4h.-6h. and the other in R.A. 18h.-20h.; the first maximum is near the equator, the other between Decl. 30° and 40° N.; the former is therefore in the constellation of Orion, the latter in Cygnus and Lyra. According to Sestini, the single blue stars occur in the same parts of the heavens.

The conclusions we may draw from M. Niesten's researches are as follows:—

1. In systems with well-established orbits, and particularly in those of short period, the two components generally have the same yellow or white colours.

2. In systems of which we possess sufficiently numerous records of the colours of the components to enable us to perceive a relation between the tints and the relative positions of primary and companion, the former is white or pale yellow when the latter is in its periastrinm, while in other positions the primary is yellow, golden yellow, or orange.

3. In these systems the companion follows the colour-fluctuations of the principal star, and frequently surpasses the latter in intensity of tint the further it moves away from the periastrium, at which point in most cases its light is white, like that of the primary.

4. An equality of tints of primary and companion is found in systems with rectilinear motion, as well as in those with closed orbits and long periods.

5. In optical groups the companion is generally blue.

These remarks are, of course, founded upon observations made by different observers, and the records of colour may thus suffer from personal influences; but in many cases one and the same observer recorded the colours of the components of a system as yellow during a series of years, and then he saw them grow paler and turn white. In other instances all astronomers agree that a certain companion is blue.

When more careful attention has been given to the question of colours, both in measuring double stars as well as in investigations of the physical condition of planets, then it will be possible, perhaps, to draw a great many more conclusions, and such to which greater probability attaches, than was in the power of M. Niesten, with the comparatively small number of observations at his command.

At present it is supposed that the fluctuations of colour in stars are caused by changes in the composition of their incandescent gaseous envelopes; these changes must in turn be only effects of another cause producing them; M. Niesten does not think it impossible that in the case of double stars this cause might lie in the relative position of the components.

SCIENTIFIC SERIALS

American Chemical Journal, vol. i., Nos. 2 and 3, present a good array of contributions from different American universities, making in all, with reviews and reports, about 215 pages. Under inorganic chemistry is to be found a description of very slightly modified methods of nitrogen and phosphorus estimation adapted to agricultural products, by Johnson and Jenkins; and a series of analyses of gummite and other uranium minerals from North Carolina, by E. Genth, &c. Among the contributions to organic chemistry is a long paper by Remsden and Iles on the oxidation of substitution products of aromatic hydrocarbons, continued from No. 1. In the first portion the authors describe solid orthokresol from their oxytoluic acid, and they further conclude from their experiments that the presence of a sulphamine group acts protectively towards a methyl group in a substituted aromatic compound submitted to oxidation. A full abstract of this and another interesting paper by Remsden and Morse on oxidation of bromparaethyltoluene, and researches on substituted benzyl compounds, by Jackson, cannot be given in our space. Thorpe on heptane has appeared elsewhere. The remaining communications are of minor interest.

Bulletin de la Académie Royale des Sciences (*de Belgique*), No. 5.—The yellow substance obtained when tetrathionic acid is poured into a solution of mercurous nitrate in water has been proved by M. Spring to be a *trithiobasic sulphate of mercury*. This substance showed some unexpected chemical properties, which M. Spring describes, and he has succeeded in forming some other new bodies similar to it, so as to complete the list of basic sulphates of mercury sufficiently for an attempt at classification of these substances.—The recent terrible catastrophe at the Agrappe coal-pit is the occasion of two communications by M. Cornet and M. Melsens, the former remarking especially on the influence of depth on the instantaneous irruption of fire-damp, and the proportion of that gas met with. (The fire-damp of the Agrappe pit, which ignited at the mouth of the pit, came from 610 metres depth, where a new gallery was being made.)—M. Renait's paper on the distinctive characters of dolomite and calcite in rocks of the carboniferous limestone of Belgium is elsewhere noticed.—There are also here two notes on Belgian minerals.

THE *Rivista Scientifico-Industriale*, Nos. 11-13, contain the following papers of importance:—Researches on the electric conducting power of carbons, by Prof. Rinaldo Ferrini.—On some new applications of the potential energy of liquid surfaces, by G. Van der Mensbrugghe, discussed by Prof. C. Marangoni.—On a telephonic microphone, by Prof. G. Cantoni.—On the endosmose of liquids and on an apparatus for filling endosmometers, by Prof. C. Marangoni.—On the mutual dependence of simple bodies, by P. Provenzali.—On some prehistoric discoveries made at Ostiano, by Dr. Ciro Chistoni.—On a new saccharometer or polarimeter, by M. Laurent.—On the kinzigite of Calabria, by Domenico Lovisato.—On the determining causes of the sexuality of *Cannabis sativa*, by Prof. P. A. Saccardo.—On the constitution of fog and clouds, by Prof. Fernando Palagi.—On a new burner for monochromatic light.—On the phenomena which accompany the electrolysis of metallic compounds, by Prof. Giuseppe Basso.—Crystallographical, optical, and chemical researches on certain minerals, by Prof. Giuseppe Grattarola.—On a new method to determine the melting-point of organic substances, by Prof. Giorgio Roster.

THE *Revue Internationale des Sciences* (June and July).—From these parts we note the following papers:—Analysis of Prof. Ernst Haeckel's treatise, "Monogenetic and Polygenetic Origin of the three Organic Kingdoms and of the Organs," by Jules Soury.—Description of the scientific balloon ascent of October 31, 1878, and remarks on the exploration of great aërial heights, by Louis Tridon.—On the Diatomaceæ of the mouth of

the Seine, by M. Manoury.—On the secreting and trophic nerves of glands, by R. Heidenhain.—On the colouring-matter of urine, by M. Masson.—On the beginnings of art, by Dr. Johannes Ranke.—On the circulation of gases and some phenomena of gaseous thermo-diffusion in plants, by J. L. de Lanessan.

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. xii. fasc. xiii.—We note here the following:—Anatomical and statistical note on cirrhosis of the liver, by Prof. Sangalli.—On albinism in batrachians, by Prof. Pavesi.—On polar systems (continued), by Prof. Jung.—On monodromic functions having a characteristic equation, by S. Pincherle.—Rapid preparation of hydroxylamine, by Dr. Bertoni.

SOCIETIES AND ACADEMIES

Paris

Academy of Sciences, July 21.—M. Daubrée in the chair.—The following papers were read:—Theory of the simple pendulum with conical oscillations, regard being had to the rotation of the earth, by M. Villarceau. He concludes that other causes than gravity and the earth's rotation intervene.—Various thermo-chemical data, by M. Berthelot. This relates to formation of diamylene, and heat of fusion and specific heat of glycerine.—Remarks on the last communication of M. Bouquet de la Grye, by M. Ledieu. He doubts the possibility of determining, even approximately, the influence of the sun and the moon on atmospheric pressure.—The last three epidemics of plague of the Caucasus, studied with regard to epidemiology and prophylaxy, by M. Tholozan. These epidemics appeared in 1804-18, 1828-30, and 1840-43. He remarks on the inefficacy of means expected to be effectual for staying the progress of the disease.—M. Schwann was elected correspondent in Medicine and Surgery, in place of M. Rokitanski.—Astronomical observations and measurement of an arc of parallel in Algeria, by M. Perrier. The arc embraces 10°. The triangulation is destined to serve for basis and control of the vast system covering Europe.—Anæsthesia by means of protoxide of nitrogen mixed with oxygen, and employed under pressure, by M. Bert. One operation, by M. Labbé, is described, and sixteen, by M. Pean, referred to. The superiority of the method is chiefly shown in the instantaneousness of the sleep and awaking. There is hardly any nausea. The excess of pressure varied between 0·15 m. and 0·22 m.—Researches on the causes of reinvasion of phylloxerised vineyards, by M. Boiteau.—M. Colladon announced the death of M. Favre, contractor of the Saint Gothard tunnel.—Discovery of a small planet by Mr. Peters at Clinton (N.Y.), on July 17, 1879.—On a generalisation of periodic functions and on certain linear differential equations, by M. Picard.—Hydrodynamic experiments with vibrating bodies, and imitation, in an inverse sense, of the forces of electricity and magnetism, by M. Bjerknes. He describes a modified form of his former apparatus.—On a phenomenon similar to that of Peltier, by M. Bouty. This relates to the experiment with metallised thermometers as electrodes, referred to elsewhere.—On the capacity of voltaic polarisation, by M. Blondlot. The following law is deduced from observations:—For a given electrode and a given electrolyte the initial capacity does not depend on the direction of polarisation.—Action of magnetism in motion on static electricity, by M. Lippmann. This action results rigorously from the existence of the inverse phenomenon, which Mr. Rowland's experiments have demonstrated; and this reversibility is a consequence of the impossibility of perpetual motion. Further, static electricity has a proper mechanical inertia, simply added to that of the electrified body.—On the laws of variations of atmospheric electricity deduced from regular observations made at the Moncalieri Observatory, by M. Denza. *Inter alia*, there are two principal daily maxima, a few hours after sunrise and sunset. The monthly electric tension reaches a maximum in February, a minimum in September. In twelve years negative electricity appeared with rain and snow, at least in 50 per cent. of the cases. The electric tension generally diminishes with the altitude.—Researches on explosive substances, by MM. Nobel and Abel.—Experimental researches on decomposition of gun-cotton in a closed vessel, by MM. Sarrau and Vieille. The pressure, heat, and volume and composition of the gases, are indicated. The latter are simple and few.—On the employment of sulphuretted hydrogen by the dry method in analyses, by M. Carnot. This mode of sulphuration has advantages, in many cases, over that of fusion with sulphur.—On the transformation of hydrocellulose into pulverulent pyroxyles, by M. Girard.—Action of fluoride of boron on acetone, by M. Landolph.—On the determination of urea, by M. Mehn.—On iron reduced by hydrogen, by M. Moissan.—Electric excitation of the point of the heart, by MM. Dastre and Morat. A series of closely successive currents may have on the heart the effect of a continuous current.—Note on the physiological action of bromhydrate of conine, by M. Prevost.—On the biliary secretion, by M. Picard. There are two differences between this and the renal secretion:—(1) An arterial system furnishes urine, a venous system bile; (2) In the biliary secretion certain substances formed in the liver are carried away by the outward movement of the liquid.—Action of the principal poisons on crustacea, by M. Yung. Strychnine and nicotine act with extreme violence; curare is less active than with vertebrates; sulphate of atropine never caused death; digitaline renders the heart's movements slower, &c.

Vienna

Imperial Academy of Sciences, May 8.—The following among other papers were read:—Old and new methods of solving differential equations by simple determinate integrals, by Prof. Winckler.—Researches on liverworts (Riccieæ), by Prof. Leitgeb.—Determination of path of two fireballs observed on January 12 in Bohemia and neighbouring regions, by Prof. Niessl.—On the employment of quarter-tones in music on the doubly chromatic piano, by Herr Gruss.—New conchylia from Mediterranean strata, by Dr. Hilber.—Diluvial land-snails from Greece, by the same.—On the *rôle* of the *Ligamentumiridis pectinatum*, by Dr. Biggs.—On compounds from animal tar, I. Picolin, by Prof. Barth.—On the internal friction in a mixture of carbonic acid and hydrogen, by Dr. Puluj.

May 15.—On the electro-magnetic rotation of the plane of polarisation of light in air, by Prof. Lippich.—On arsenate of zinc and cadmium, by Herr Demel.—On two peculiar surfaces of the sixth order, and on a certain group of curves of the third and fourth order, by Herr Cantor.—On tertiary fossils brought by Dr. Tietze from Persia, by Herr Fuchs.

May 23.—On the formation of cinchomeronic acid from chinine, and its identity with a pyridindicarbonic acid, by Dr. Weidel and Herr Schmidt.—Action of oxalic acid on carbazol, by Dr. Sinda.—On the decomposition of sulphydantoin by baryta hydrate, and on a peculiar iron-reaction of thioglycolic acid, by Herr Andreasch.—On bromoxyl derivatives of benzol, by Dr. Benedikt.—On the fossil fauna of the Vypustek cave in Moravia, by Prof. Liebe.

CONTENTS

THURSDAY, AUGUST 7, 1879

SCIENCE TEACHING IN SCHOOLS

SIR JOHN LUBBOCK, one of the two or three members of Parliament who know what science means, has again brought forward his motion for the introduction of science teaching into schools. As on former occasions, the motion was lost, though those who opposed it, and especially those connected with the Education Department, were at a loss to give any clear reason for not agreeing to it. One of the chief reasons apparently why the Department is afraid to hold out inducements for the teaching of scientific subjects, is that there is scarcely an inspector qualified to examine on the subject, a humiliating revelation of the lamentable state of education at our universities. But Sir John Lubbock also pointed out another apparently trivial but really powerful reason for our half-educated rulers shrinking from assenting to the introduction of science teaching into schools; the very name "science" acts as a bugbear. It is indeed a pity we have no such word as *Naturkunde* to indicate the sort of thing—"Natural Knowledge"—that Sir John Lubbock and the intelligent minority who are with him, wish to be taught to the boys and girls of our elementary schools. The fact is that what is wanted is a knowledge of things instead of mere words; it is really a question of how to use the eyes and how to train the mind; the pages of nature as opposed to the pages of a book; in brief, education *versus* mere instruction. How deeply working men feel the want of natural knowledge when they grow up is shown by the increasing number of technical schools that are springing up, evening classes for the teaching of science, popular scientific lectures, local scientific societies, and other similar efforts to make up for a deficient education in youth. It seems simply incomprehensible how any member of Parliament having at heart the real welfare of the people, physical, intellectual, and moral, should not heartily support Sir John Lubbock's attempt to give something like reality to our elementary education. Even the opponents of the motion seem to approve of "object-lessons," ignorant that science teaching, in Sir John Lubbock's acceptation, is just the same thing "writ large,"—simply object-lessons taught by competent teachers in a systematic and accurate manner. As to the outcry against increasing the burdens of teachers and pupils, those who raised it must have known that it was quite irrelevant. The advocates of science teaching do not wish to make it an additional, but only an alternative subject, to be taken at the option of the teachers, for grammar, geography, or other existing subject, for which payment is made. For indeed already is science put down as one of the subjects in elementary schools, but only as an extra subject for which no payment will be made, and for the teaching of which, therefore, no inducement is held out to the teachers. Then as to cost, Sir John Lubbock told the House—"Contrary to what was believed in some quarters, his proposal would really not involve any appreciable cost. The little books would come to no more than those on history or grammar; while the sun, moon, and stars, rain and dew, wind and light, air and water, heat and cold, stones and flowers, were before us all; and even if a few objects as illustrations were required, they could be obtained for a few shillings. He wished for nothing difficult or abstruse, nothing beyond the range of the children's minds and daily experience. In mechanics the simple forces might be explained to them—why carts were put on wheels, how levers and pulleys acted, the use of the screw and wedge; then the nature and relative distances of the principal heavenly bodies, the primary facts relating to air and water in agricultural districts, the character of the soil, the reason for the rotation of crops, the origin and principal qualities of such substances as chalk, coal, iron, copper, &c.; the succession of the seasons, the flow of rivers, the growth of plants; the fundamental rules of health, the necessity for ventilation and cleanliness, and last, not least, the need for industry, frugality, and economy. Explanations of these simple and every-day things would be most interesting and useful to the children. So far from cramming and confusing them, you would introduce light and order into their little minds, and give them an interest in their lessons which under the present system they rarely felt."

And, as Dr. Playfair put it, of what use was it to spend a long time in teaching children in mining districts grammar? Would it not be of greater importance to teach them about the dangers they would have to meet in their calling—about fire-damp and after-damp, for instance? In the same way, should not a child destined to become an agricultural labourer be taught something about the earth, the properties of manure, and other subjects connected with cultivation?

The fact is that some means should be taken to enlighten members of Parliament themselves as to what education, as contradistinguished from instruction, and natural knowledge. as contradistinguished from book knowledge, really is; and our readers might do worse at the certainly approaching election than arouse the minds of candidates to the urgent necessity of bringing the country, in the matter of science teaching, up to the level of those countries which, by the superior knowledge of their manufacturers and technical skill of their working men, are rapidly outstripping us on our own ground.

MAUDSLEY'S "PATHOLOGY OF MIND"

The Pathology of Mind. Third Edition. By Henry Maudsley, M.D. (London: Macmillan and Co., 1879.)

GREAT as has been the growth, in recent years, o the tree of knowledge, there is no branch in which it has undergone so much actual development, as well as mere expansion, as that of psychology. Though formerly nearly isolated, being as it were but imperfectly grafted on to the main stock, curious rather than beautiful, looking irregular, dry, and withered by the blight of theology and bad metaphysics, it now presents a compact system of branches and foliage, arranged with all the symmetry of organisation; the main stem springing from the branch of biology as this does, in its turn, from that of the physical sciences; moreover, the process is still continuing, for fresh buds may be seen in the newly-formed structures, some of which, *e.g.*, sociology, philology, æsthetics, and the science of religious beliefs are already beginning to unfold. The causes of this accelerated growth it is needless here to discuss; the principal seems to be the gradually extended application of natural law

which has taken place since the impulse it received long ago from Descartes; the more immediate causes being the greater development which biology has undergone, through both induction and deduction; and especially the advances made in the physiology of the nervous system, by which a clearer understanding has been obtained of the correspondence between consciousness and bodily state. It has come to be perceived that mind, instead of being considered as a substance superadded to the body, or even as the power of consciously knowing and acting, is better regarded as the power, more extensive than the field of reflection, which highly organised beings possess, of performing their most complex actions; this regulation of action being vested in the nervous system as its peculiar function. Thus, mind appears homogeneous with life—being power similar in kind, but differing in degree of speciality. Still, the eternal mystery of the connection of consciousness with the objects of consciousness remains almost the same; the gulf still gapes widely, and cannot be bridged, though perhaps its borders may be a little more clearly defined. Also, it may still be open to discussion whether an organism possesses these remarkable powers *necessarily—i.e.*, in virtue of its organisation.

The development of the science having proceeded so far, it might be considered not unreasonable to look for fruit on it already, in the shape of immediate practical application; and the belief that this search had been successful was the *raison d'être* of the first appearance of this work, as the author explains in his preface. Certainly some may consider the fruit as yet unripe, or at any rate the seed it contains unready for germination, but this would be matter of individual taste. For it is at least extremely probable that if mind be a function of the body, its health will depend on laws and conditions similar to those of the other vital functions; and that when disordered, similar methods of restoration will be serviceable in either case. But the common psychological doctrines were, till lately, quite inadequate to show in what mental disease consisted. Certain affinities with other diseases had long been recognised, *e.g.*, its dependence upon certain general bodily states, or being induced by definite causes; also the prominent features of pain, excitability, and weakness, separately or together, frequently characterised the derangement of other functions also. The author shows that the correspondence may be traced still further: that, like many other morbid conditions, insanity consists essentially in failure to attain to, or retrograde departure from, the normal stage of development. But in one respect especially the present edition claims and is entitled to some degree of novelty, or even originality; namely, in the recognition of the particular mental faculty which suffers lesion in insanity. Until pointed out by Comte, Spencer, and Lewes, how large a proportion of our total environment is constituted by society, sufficient attention had not been paid to the extensive position occupied by that faculty of the mind employed in regulating our actions in relation to the social medium. Just as the motion of a planet may be resolved into a purely individual movement of rotation, and an orbital movement which it performs as member of a system, so the activities of the human mind are partly concerned with the individual alone, partly dependent on the presence of other members of a system. The latter class absorb by far the greater part of the total activity, and really constitute the chief differentia between the mind of man and that of animals, comprising those altruistic impulses which are the highest development of our activity, as is well shown in Spencer's "Principles of Psychology"; but, like all recent highly developed faculties, they do not appear in the individual completely formed at first, but in a germinal state, requiring training and exercise to bring them to the condition of full perfection; and because of their difficult development are more prone to suffer degeneration. This notion forms the foundation of the theories of education and of insanity, the latter showing that when the higher functions fail to be developed, or fall into abeyance, their place is taken by less developed faculties, which preceded them in order of evolution; or, to return to the analogy employed above, the rotatory gains at the expense of the orbital movement. This view of faculties of higher and lower faculties, *i.e.*, of greater and less perfection, and their somewhat mutual opposition, is essentially the same as Spinoza's theory of ethics. It is the key-note of the present volume, the substance of which consists of the attempt to show its existence in nature.

If the execution of the book were as satisfactory as its conception, it would indeed deserve most unqualified praise; but it is impossible not to feel, on perusal of the work, that in many respects there is much shortcoming, leaving room for further improvement, the aim not being realised owing to the difficulty of the passage from the abstract to the concrete. For though the highest generalities appear correct, are clearly stated, and well enforced, yet there is much dearth of the less general laws—the "middle propositions" which Bacon describes as of such importance in understanding the details of a subject, and of such value in practice—the absence of which is acknowledged by the author, when he says that we do not at all know why the disease should present different aspects in different cases. Also, different parts of the book are of unequal value, the best decidedly being those devoted to pure psychology and mental pathology, in which varieties of character, morbid tendencies, and the various motives, impulses, feelings, &c., are discussed, the author finding abundant occasion to display his talents as a moralist and eloquence as a writer. Next in order of merit come the sections on the phenomena and treatment of insanity; the former of these, though clear, correct, and tolerably full, do not add much to what has been written by previous observers. Lastly comes the physical aspect of the subject, which seems decidedly weak; for though this is undoubtedly most obscure, yet there is much repetition of somewhat crude theories of the correspondence of physical with psychical states. The general pathology, too, is but feebly represented; it may, perhaps, be no worse than is usual in modern text-books, but its usefulness is greatly impaired by want of those invaluable "middle propositions" which are created by clinical genius and communicated by tradition.

The first chapters are new, and are devoted to the consideration of sleep, dreaming, somnambulism, hypnotism, &c., which, being states analogous to insanity, though more open to observation, might be looked to for illustration and explanation of the leading problems of the disease,

e.g., its nature and genesis. In this way, the author approaches the subject of delusion, which really, in its widest sense, may be said to constitute the essence of insanity; this problem is twofold: 1. What is the primary *mental* deviation? 2. On what bodily disturbance does this depend? The intellectual is shown to be convertible into and dependent upon emotional disturbance; and it is well demonstrated how much our state of feeling—whether temporary as mood, or permanent as character—influences not only the imagination, but even perception. A delusion may be regarded as a picture formed to suit a certain frame of mind. In showing how incorrect figures arise from morbid feelings, the author is less explicit; he adopts the sensationalist or association theory, but a clearer notion might probably be afforded by a more Platonic or idealistic theory of cognition, of which there even is some suggestion once or twice. Although the author adopts the emotional source of delusion as a rule, yet he makes—rightly or not—exception in certain examples of hallucination, *e.g.*, those arising in connection with epilepsy, some toxic conditions, and in childhood—which he assigns to primary derangement of the sensory centres. Owing to the defective state of general pathology, as before stated, the mode of dependence of feeling on corporeal condition is far from being satisfactory. Next follow long chapters on the causation and prevention of insanity, treated first on the psychical, then on the physical, aspect; in both, much stress is laid on heredity as a factor: the former contains the most interesting and original parts of the work. The rest of the volume is of more special and technical character, being given to a tolerably full and accurate description of the disease, which is regarded as fundamentally the same in all cases, though wearing some variety of aspects, thus affording matter for classification; that here adopted is the same as in previous editions: the description commences with a chapter on the insanity of early life, and concludes with one upon treatment, on which the author holds rather sceptical opinions concerning the efficacy of drugs, especially narcotics.

In conclusion we may remark that, although the author may be considered to have attained success in his chief aim—the setting forth of the pathology of mind—yet no more than a mere outline has been accomplished, and much of this appears to have been derived from borrowed rather than purely original ideas, the chief originality of the author lying in their present application; and it is to be regretted that it is so lacking in thoroughness, for this may suffice to prevent an otherwise highly-readable and well-designed book from acquiring extensive adoption as a text-book and permanence as a work of reference.

LUBBOCK'S SCIENTIFIC LECTURES

Scientific Lectures. By Sir John Lubbock, Bart., M.P., D.C.L., LL.D., &c. (London: Macmillan and Co., 1879.)

THE six lectures of which this volume consists treat of the relations of insects and plants, the habits of ants, and prehistoric archæology. They are well illustrated by numerous woodcuts, and are written in the clear and pleasing style which characterises all Sir John Lubbock's works.

The first lecture—On Flowers and Insects—gives an excellent account of some of the more interesting cases of the special adaptation of flowers for insect fertilisation, but contains nothing that will be new to the readers of NATURE. The next—On Plants and Insects—introduces us to a variety of interesting and less generally known relations between the insect and vegetable worlds, which serve to confirm in a striking manner the general axiom, that the minutest details in the structure of living things, are or have been of use to them. We learn now how much of what gives a special character to many plants—their hairy or woolly stems, their spines, their glutinosity, the hairy rings inside their flowers, their drooping habit or glossy surfaces—are all of use in various ways to keep off insects which would rob them of their honey or pollen without effecting fertilisation. Another relation here dwelt upon is that of the colouring of caterpillars in accordance with the plants they feed upon, and it is particularly instructive as showing how impossible it is to decide whether a creature is protected by its colour unless it is observed in its native haunts. Few objects are more beautiful, or more varied in colour and markings, than the caterpillars of our different species of hawk-moths. They are often adorned with the most exquisite violet, blue, or white markings on a green ground, and sometimes also with ocellated spots of brilliant colours, yet in most cases these are so arranged and balanced as to harmonise with the general tints of the foliage and flowers of the food plant and thus render the insect quite inconspicuous at a little distance. In addition to the excellent woodcuts of caterpillars which illustrate this part of the work there is a coloured frontispiece which appears to have been added as an afterthought, for not only is there no reference to it in the text, but not even the names of the insects are given on the plate itself.

The next two lectures—On the Habits of Ants—give an excellent summary of those interesting researches by which Sir John Lubbock has added so much to our knowledge of these insects. Especially curious are the illustrations of the stupidity of some ants. One species is such a confirmed slave-owner that it dies of hunger if not fed by its slaves—a fact recorded by Huber and confirmed by our modern observer. Even more striking as an example of want of intellect is the experiment recorded at p. 81, where some ants went round a distance of ten feet to get at honey rather than jump down about one-third of an inch; and although they tried to reach this small height, from a little heap of earth to the glass on which the honey was placed, and could even touch it with their antennæ, yet they had not sense enough to pile up the earth a little higher but gave it up in despair and went round by the paper bridge ten feet in length!

Numerous experiments show that some sense analogous to smell, rather than vision, guides ants to their food, and thus no actual power of communication from one ant to another is needed to account for the numbers that follow when one has found out a store. Some very ingenious experiments prove, however, that an actual communication does exist when larvæ are concerned, and that one ant is able to tell its fellows whether there are few or many larvæ to be attended to. The experiments as to the effects of coloured light on ants are interesting, showing

that they have a great dislike to violet light however obscure, and a preference for dark green and red; but we can hardly tell whether this effect depends on any visual perception, or on a general sense of discomfort in the one case and pleasure in the other analogous to the effects of heat and cold upon ourselves.

The last two lectures give a clear and condensed summary of the present state of our knowledge as to prehistoric man, and are well worthy of study by those who may be inclined to doubt the value of the conclusions arrived at by the new science of Prehistoric Archæology. There is here of course nothing but what is well known to all who have paid attention to the subject. It is, however, interesting to note how sharp and striking the contrast between the Palæolithic and Neolithic ages appears, when their characteristic features are briefly summed up side by side as we here find them. Whether we consider the tools, weapons, and other works of art, the character of the contemporary animals, the physical geography of the country, or the distribution of man himself, we cannot but be impressed with the profound chasm, which in Europe at least, separated the Palæolithic from the Neolithic man. And as, since the glacial epoch passed away we have no evidence of any physical changes calculated to produce such a chasm, it seems natural to suppose that it was the result of the cold period itself, and that, as many geologists now maintain, Palæolithic man lived before the glacial epoch and during interglacial mild periods, while Neolithic man made his first appearance only when the ice-age had finally passed away. On any other theory we have no adequate cause adduced for a discontinuity so vast in its proportions and extending over so wide an area.

A. R. W.

OUR BOOK SHELF

Dairy Farming; or, The Theory, Practice, and Methods of Dairying. By J. P. Sheldon, assisted by leading authorities in various countries. Part I. (London: Cassell, Petter, and Galpin, 1879.)

THE prospectus of this work promises us a thorough treatment of all parts of the important subject of dairy farming. The selection, breeding, and feeding of dairy cows; the production, treatment, and disposal of butter and cheese; the plants or crops used in feeding animals; dairy buildings, and soils adapted for dairy farms; such are some of the subjects embraced in the scheme of Mr. Sheldon's serial work, the publication of which, in monthly parts, has recently commenced. The first number, being chiefly occupied with general introductory remarks, hardly affords a fair sample of what the bulk of the book is likely to be. These prefatory pages do, however, contain a good deal of interesting matter—matter important to many persons besides dairy farmers. Some of the statistics of milk- and cheese-production here given are very striking. For instance, we are told (p. 9) that about 500,000 tons of ripe cheese could be made from the milk annually produced in the United Kingdom, when the quantity of milk required for rearing and fattening calves has been deducted. But, in point of fact, much milk is consumed as such in food, while from that which is submitted to further dairy operations a good deal of butter is made. The approximate estimates, therefore, for the amounts of milk and milk-products in question will stand somewhat as follows for the United Kingdom:—Milk annually consumed as such, 525,000,000 gallons; 126,000 tons ripe cheese from 350,000,000 gallons; 89,295 tons of butter from 550,000,000 gallons. When the cheese, butter, and condensed milk imported from abroad are added to the home production, some notion of the vastness of the amount of dairy products consumed by the population of the British Isles may be gained. Thus, 98,000 tons of cheese are annually brought into this country from the Continent, the United States, and Canada; while the yearly import of butter approaches 90,000 tons. The value of our imports of butter and cheese together is just 15,000,000*l.* sterling.

It seems somewhat ungracious to say one word in disparagement of any part of an undertaking which promises so well as does Mr. Sheldon's "Dairy Farming." But we feel bound to hint that more care should be taken in securing the accuracy of any physiological and chemical explanations that it may be thought expedient to introduce into the volume. The figures and statements on pp. vi. and vii. of the "Introduction" require revision. We give an instance. We are told (p. vi.) that 1 lb. of milk contains ·65 ounce of flesh-formers and 1·51 ounce of heat-givers. Now the latter figure has been reached by adding together the fat and sugar of the milk without the previous conversion of the former into its starch-equivalent. It is needless after this to say how idle are all the subsequent comparisons of milk with other foods, vegetable and animal.

Marcus Ward's Arithmetic. J. W. Marshall, M.A., Assistant-Master at Charterhouse School. (London: Ward and Co., 1879. 232 pp.)

THIS is a neatly got up arithmetic; it contains a great number of exercises, covering the usual ground occupied by such treatises, has a modicum of explanatory matter, and calls for no further comment. There are no answers at the end, but they can be got in a separate form.

A Collection of Problems on Plane Geometrical Drawing, including Problems on a few of the Higher Plane Curves, &c. By E. F. Mondy, A.R.S.M. 2 vols. Text and Plates. (Tokei. 127 and ix. pp.)

A COLLECTION of problems arranged for the use of the students in the Imperial College of Engineering, by the First Whitworth Scholar (1871), and Professor of Drawing in the College. The author's aim has been to arrange the earlier problems so as to render it of service to students to work these while reading Wilson's Geometry, the text-book used in the Mathematical Class. The treatment is mainly founded upon the recognised English text-books, but a novel feature, perhaps, is the extent of space devoted to the conic sections and the higher plane curves, "especially as regards the use of equations to these curves and to the various geometrical elements connected with them."

Thus constructions are given for the tangents and radii of curvature, and problems in areas are worked out.

The book is, under the circumstances, very fairly got up as regards the printers' work, and the matter is deserving of commendation for its arrangement.

Our own experience of Japanese students is that they take very kindly to this branch of mathematical instruction, and the productions of some we could name rank among the neatest we have seen. The plates are in a separate work from the text, a convenience in some respects for the student.

Essai sur les Principes fondamentaux de la Géométrie et de la Mécanique. Par M. de Tilly. (Paris: 1878. 190 pp.)

THIS valuable treatise forms the first *cahier* of the third volume of the *Mémoires de la Société des Sciences physiques et naturelles de Bordeaux*, 2e série. The first chapter—General Geometry—discusses the elementary notions and axioms of the subject in a way that will satisfy an anti-Euclidian, but we fear the nerves of Euclidian adherents would suffer a shock at the bare-

faced manner in which triangles and figures are moved about and turned about and placed upon one another.

The second chapter treats of the subject as handled in the Elementary Treatises, taking chiefly for the basis of remarks the fourth edition of the Geometry, by Messrs. Rouché and De Comberousse.

Chapters III. and IV. are occupied with Trigonometry, and Chapter V., closing the work, treats of Mechanics. The volume is too technical to allow of an extended criticism here, but we can commend it to geometrical students. No statement is made as to how it comes to pass that such a volume was issued under the auspices of the Society named above.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

New Methods of Moving Ordnance

In anticipation of an interesting paper and discussion at the intended meeting of the British Association at Sheffield, a complete set of working models has been prepared at the Floating Dock, North Shields, to explain several new applications of a new method of moving ordnance with ease and rapidity of motion in small space, with economy of time and labour.

The most recent of these improvements is an adaptation of the principles of the tramway and tram car, in making use of the perfectly level surface, and the retaining groove, either on the ship's deck or on the platform of a battery. But instead of flanges on the wheels, that have a tendency to clog and compress dirt into the grooves, and "gag" on the edges, a hanging longitudinal guide-plate projects below the wheels on the inside of the rails; this allows greater freedom of action to the wheel and gives greater security, and in order to attain greater power of resistance to any shock or concussion, the guide plates are strengthened by a cross connecting the plate between them. The gun carriage slide has turn-table pivots on four wheels, that can be placed anywhere; as for the real or imaginary centres of motion at the ends, or centrally or to correspond with the present A B C D pivots of the Royal Artillery, which when in line or parallel or at any angle to each other act as stationary or moving pivots or fulcra for a lever movement of the slide, to turn or move in any direction on perfectly straight lines, as the shortest route between any two points, and also as best adapted for the application of a direct action of any of the usual mechanical motive powers.

North Shields, August 1 GEORGE FAWCUS

"Law of Frequency"

THE term "law of frequency" seems to be used in two distinct senses by mathematical writers. In the ordinary theory the ambiguity leads to little confusion except to beginners; but this is owing to a fortunate, though altogether special, property of the hypothesis on which the theory is based. When we come to investigate other possible theories, it becomes highly important to keep the distinction in mind. Suppose, for clearness' sake, that we have before us a large number of measurements of a single unknown quantity. On examining them we find that a considerable number agree pretty closely with each other, several are more obviously discrepant, while one or two are widely so. Conversely we are led to think of the frequency with which a given measurement occurs as a function of the magnitude of the measurement itself. Denoting this magnitude by x, we may represent the relative frequency of its occurrence by $\phi(x)$. This function is called the "law of freqnency of the measurement x," and it is in this sense that statisticians often use the phrase.

But if we consider all the possible measurements that may be made of the quantity, we see that their number is practically infinite The relative frequency of any proposed measurement becomes therefore infinitesimal, and we must seek for some other expression. This we find by inverting our ideas, as it were, and asking, not "What is the frequency of a given measurement x?" but "What is the probability that a given measurement shall lie between the two very near values x and $x + \delta x$?" Suppose that our particular theory gives us this latter probability as $\psi(x)\,\delta x$. Then mathematicians generally are wont to call $\psi(x)$ "the law of frequency of the measurement x."

A little consideration will show that on one hypothesis only are $\phi(x)$ and $\psi(x)$ necessarily of the same form. This hypothesis is that the arithmetic mean of our fallible measurements is the best value of the quantity measured which we can obtain from them. From this the ordinary law, $\phi(x) \propto e^{-h^2x^2}$, easily follows.

But if the nature of our measurements (or other discrepant magnitudes) be such as to suggest that some other mean is likely to be nearer the truth than the arithmetic mean, we shall find that the forms of $\phi(x)$ and $\psi(x)$ are not the same. It seems, therefore, desirable that a real distinction in the things signified should be marked by a corresponding distinction in the terms applied to them. If it be not too bold a suggestion, might we not "desynonymise" the terms "law of frequency" and "law of facility," keeping the former for the function I have called $\phi(x)$, and the latter for the commoner function I have represented by $\psi(x)$? DONALD MCALISTER

St. John's College, Cambridge, July 28

Carica Papaya

THANKS to Mr. Whitmee for his timely correction of my perhaps too dogmatic assertion as to the seeds of the Papau being rejected by birds, at p. 241. Had I not written off-hand I should have qualified the sentence "the birds however will not touch them," *i.e.* the fruit, by adding "as far as I have observed."

We had flocks of small birds inhabiting the casuerinas and banyans which shaded our sea-side quarters at Rivière Noire, Mauritius; they were mostly small birds such as "bengalis," (*Estrelda amandava*), "senegalis," (*Estrelda astrilda*), "calfats," (*Munia oryzivora*) "tuit-tuits," (*Oxynotus ferrugineus*), cardinals, crithagras, serins, &c., as numerous as finches and sparrows in our English gardens: but never did I see any of these birds, which were as bold and tame as possible, peck at the papaus either on the plants or on the ground; had they been in the habit of doing so I must have observed them. The "martins" or minas of the interior did not trouble us with their visits and noisy chatterings, so I cannot say whether they affect the papau seeds much. It is possible that the "pigeons marrons" and various "tourterelles" may have fed on the papau fruit but I never found any of the seeds in their crops.

The flying foxes, "collets rouges," (*Pteropus Edwarsii*), used to come down in numbers to eat the mangoes of our neighbour, Mons. Genéve; when we used to shoot them on moonlight nights and find them remarkably good eating, but I never knew or heard of their eating the papau, which perhaps they do. The conditions of the Mascarene and Navigator's islands are probably different, as the *Carica* certainly does not spring up as a weed wherever forests are cleared in Mauritius, or Bourbon. The *Carica papaya* figures as a *cultivated* and not an *intrusive* plant in Dr. Charles Pickering's table of observed localities of plants introduced throughout Polynesia; distinguishing for each plant, whether it appears to be native, or spontaneously disseminated, and whether when introduced apparently by the hand of man it has become naturalised or *intrusive*. Certainly Dr. Pickering's work is out of date (1848), and I have not yet seen his new work *Chronological History of Plants* (Trübner, 1879).

Whilst on this subject I may subjoin a paragraph I came across in a number of the *Gardener's Chronicle* about the papau, with which I conclude.

"*Utilisation of the Papaw.*—The peculiar properties of the Papaw (*Carica papaya*) in causing the separation of animal tissues, and thus rendering newly-killed meat tender, is a fact that has been frequently written about and commented upon by travellers. Our contemporary, *The Chemist and Druggist*, suggests, as a 'possible specialty,' the production of some convenient preparation from the tree which should contain the same properties as the leaves, or whether the leaves themselves might be dried and still retain their activity. 'There is no doubt,' they say, 'that a preparation which really embodied

these virtues would be very popular, and that it would soon become one of the necessaries of life, without which no careful housekeeper would allow herself to be left.' It is further pointed out that, as the tree is abundant, and the expense of collecting the leaves would probably be very small, it would be quite worth while to procure a quantity either of the leaves or the juice from the West Indies, and endeavour to obtain a suitable preparation therefrom. If the leaves are brought they might be packed fresh in barrels, which should be filled with salt water—not sea water—and in this way imported; 'or the juice might be expressed from them and saturated with salt, or preserved with benzoic or salicylic acid, and sent over in any convenient vessels. Experience would prove if they would retain these properties when so treated.' These hints may be worth the consideration of some of our readers in countries where the Papaw is abundant."

Anglesey, Gosport, August 4 S. P. OLIVER

The Pacific Salmon

THE reviewer of the U.S. Fisheries' Commission Report, 1875-6, in NATURE, vol. xix. p. 429, pointedly refers with doubt to a statement that "so far as yet observed the adult fish of the Pacific salmon (*Salmo quinnat*) all die after spawning" quoted from a memorandum which I wrote on the subject for the information of the New Zealand Government.

In support of this I would refer to the evidence given in a previous volume of the same reports, 1872-3, p. 191 and elsewhere. This phenomenon, remarkable though it be, is so entirely in accordance with my own observations made during two seasons spent on the upper waters of the Columbia river in 1859-60, and with the opinions I heard expressed by Indians and trappers, that I thought I was justified in mentioning it as a peculiarity of importance.

It may interest your readers to learn that a million of salmon ova of this species have been imported to New Zealand, and that over 700,000 have been hatched and that some 40 rivers have been stocked with the young fish.

Through the great liberality of the American Government at the instance of Prof. Spencer Baird, this invaluable addition to the future food resources of the Colony, has been effected at the cost of only a few hundred pounds to the Colonial Government.

JAMES HECTOR

Colonial Museum of New Zealand, Wellington, May 10

A New Spectroscope

IN NATURE, vol. xx. p. 256, a description of M. Cornu's spectroscope for observation of the ultra-violet rays is given.

The lens of the collimator, and that of the observing telescope are said to be composed of a double convex lens of quartz achromatized by means of a plano-concave of Iceland spar, both cut parallel to the optical axis. His prisms are said to be of quartz.

Will you allow me to state that I have used an exactly similar arrangement for the last three years, with the exception that the two prisms are of Iceland spar, which has higher dispersive power. The object glasses were ground and polished for me by Mr. Ahrens of the Liverpool Road. I named the plan about two years ago to my friend Prof. McLeod, and have found it very successful in working. WILLIAM H. STONE

14, Dean's Yard, Westminster, S.W., August 4

"The Rights of an Animal"

I BELIEVE that when a writer feels himself to have been entirely misrepresented by his reviewer, editorial fairness allows him, at least in such journals as admit correspondence, to set himself right with the reader. The reviewer of my "Rights of an Animal" in NATURE, vol. xx. p. 287, says that, when I claim for animals "the *same* abstract rights of life and personal liberty with man," I use an ambiguous word which casts its shadow over the entire work and makes it unsatisfactory. I should have thought "same" clearly meant "identical." My reviewer says that this cannot be my meaning, because I allow animals to be killed for food and to be worked. He forgets that I have shown how the law of self-preservation overrules the rights both of animals and of men, that it warrants our checking breeding in animals, and that the animals which I allow to be killed or worked were only allowed to come into life for those purposes.

He says that I consider it "immoral to eat shrimps and lobsters." I have indeed asked how we are to defend the killing of "fresh- or salt-water fish or crustaceans," but I have suggested an answer, and have merely added "is this plea sound?" That I leave a question doubtful does not justify a reviewer in saying that I decide it in a particular way.

I will not follow him into an argument between a very sophistical "philosopher" and a very stupid lobster, wherein the former gains an inglorious victory; but, when he in his proper person reproduces, anent another question, one of the philosopher's arguments, and charges me with "the same inconsistency of principle"—because "if man has a moral right to slay a harmful animal *in order to better his own condition*, he must surely have a similar right to slay a harmless animal, *if by so doing he can secure a similar end*"—I must protest that "principle" and "self-interest" are not synonymous, and that a writer who can pen such a sentence is no more capable of reviewing an ethical essay than I of reviewing a book on diamagnetism.

Lastly, he has (even in transcribing my title-page) omitted all mention of my reprints from Lawrence's interesting and very scarce work, and has conveyed to the reader an impression that my book consists of only about 60 pp., an impression very damaging to the chance of the reader buying or even borrowing it. EDWARD B. NICHOLSON

London Institution

Intellect in Brutes

MR. HENSLOW's question (NATURE, vol. xix. p. 433) reminds me of the celebrated carp and bucket of water problem, put by King Charles the Second. He had better have put it thus—"Did ever a person know a dog (or other animal) ring a bell to bring a servant, &c." How can any one tell if an animal goes through any "process of reasoning," save by the results? What will Mr. Henslow say to the following, for which I can vouch, as can others now living? For my part, having watched animals since my childhood, I am fully convinced of their "powers of reasoning" to a certain extent.

Many years ago we lived in Cambridge, in Emmanuel House, at the back of Emmanuel College. The premises were partly cut off from the road by a high wall; the body of the house stood back some little distance. A high trellis, dividing off the garden, ran from the entrance door to the wall, in which was another door, or gate. A portion of the house, a gable, faced the trellis. These particulars are necessary, as you will see.

We were, after some time of residence, extremely troubled by "run-away-rings," generally most prevalent at night, and in rainy, bad, or cold weather, which was a great annoyance to the servant girls, who had to cross the space between the house and the wall, to open the outer door in the latter, and were thus exposed to wet and cold.

The annoyance became so great that at length a cousin and myself, armed with wicked ash saplings, watched behind the trees on "Jesus' Piece," bent on administering a sound thrashing to the enemy, whoever he was, that disturbed our "domestic peace." *Mirabile dictu!* the rings continued, but no one pulled the bell handle! Being a very old house, they were now of course set down to ghosts! but not believing in those gentry, I was puzzled. Chance, however, revealed the originator of the scare.

Being ill I was confined to the wing facing the trellis, and one miserable, blowing, wet day, gazing disconsolately out of the window, espied my favourite cat—a singularly intelligent animal, much petted—coming along the path, wet, draggle-tailed, and miserable.

Pussy marched up to the house-door, sniffed at it, pushed it, mewed, but finding it firmly shut, clambered up to the top of the trellis, some eight or ten feet from the ground, reached a paw over the edge, scratched till she found the bell-wire which ran along the upper rail from the wall to the house, caught hold of it, gave it a hearty pull, then jumped down, and waited demurely at the door. Out came the maid, in rushed Puss. The former, after gazing vaguely up and down the street, returned, muttering "blessings," no doubt, on the ghost, to be confronted by me in the hall.

"Well, Lydia, I have at last found out who rings the bell." "Lard, Master! ye harvent sure*ly*"—she was broad "Zamerzetsheer." "I have; come and see. Look out of the breakfast room window, but don't show yourself." Meanwhile, I went into the drawing-room, where Mrs. Puss was busy drying herself before the fire. Catching her up, I popped her outside of the door, and ran round to my post of observation.

Puss tried the door, and mewed, thinking, probably, some one must be near, and after waiting two or three minutes in vain, again sprang up the trellis, and renewed her attack on the bell-wire, of course to be immediately admitted by the delighted maid, who this time did *not* cross the yard, nor ever again, I fear sometimes to the inconvenience of visitors, if puss was waiting for admission.

Now I think Mr. Henslow will concede that no one ever taught that cat how to ring the bell by *pulling the wire*. To my mind she must have gone through the following process of reasoning:—1. She noticed whenever the bell rang the door opened. 2. In clambering up the trellis to the house-top she accidentally moved the wire, and caused the bell to ring. This probably occurred several times before she noticed it, but having once done so, she repeated it, purposely, whenever she wanted entrance; I have often made her do it for the amusement of friends, by turning her out from her snug nest by the fire on cold or wet days.

I have known dogs shake a door violently to attract attention and be let in. A dear old spaniel of ours, at the Cape, used to rattle the empty bucket if he was thirsty, and then come and look in our faces. My horse will come up from his pasture to the pump in the yard and whinny till some one gives him water. I have known several dogs rear up and place their paws on the old-fashioned "thumb-latch," and let themselves in. Surely all this is "abstract reasoning"? These things are not taught them, and they do not do all of them, even by imitation. I don't go to the pump and whinny, if I want drink! nor rattle a bucket! No! they come by a process of mental reasoning, and I am convinced all animals have it to a certain degree, more or less. I could multiply instances by the page-full, but have already taken up too much space. Among others I could confirm the gnawing of water-pipes by rats to get at the water.

Brit. Consulate, Noumea, May 30 E. L. LAYARD

As a contribution to the doubtless numerous cases in which dogs have recognised the representations in paintings, I put on record the following fact:—

I have in my possession a small picture in which several dogs are represented; a small spaniel was frequently found standing on a chair before the picture and barking at it, and this was the only picture of which he took any notice. P. B. M.

Black Lizards

FROM the interesting letters of Messrs. Giglioli and Ernst it appears that lizards are found of a black colour where, according to received ideas, they ought to be nearly white. How is this anomaly to be explained?

With all due respect to those who have made this subject their study for tens of years, it seems to me that they keep too exclusively to one single proposition, which may be thus enunciated: *An organism is made to prey or be preyed upon.* What I am inclined to maintain is that an unfavourable climate is the common enemy of all, an enemy that must be eluded. If an animal be thrown into a climate too hot, or too cold, it will die if it cannot speedily adapt itself to its altered surroundings. We see a mild case of this adaptation to environment in man himself, the pale-face of temperate zones becoming soon in torrid zones bronzed, and, after a few generations, black. The black dermal covering is therefore clearly the one which is best adapted for extreme heat.

I submit then that here we have the case of the lizards simply stated. On the sandy beaches of Los Roques and Orchila, covered with a very scanty vegetation the pitiless rays of the sun must fall on the lizards in a most uncomfortable manner, to say nothing of the heat reflected and radiated from the ground itself. From the moment the islands were separated from the mainland, a change would commence in the lizards to suit them to their altered position, a change which has resulted in their present wide divergence from the mainland type so far as colour is concerned. WM. ACKROYD

Sowerby Bridge, July 31

Spicula in Helix

THE spicula observed by your correspondent (NATURE, vol. xx. p. 316) lying underneath the albuminiparous gland in some specimens of *Helix aspersa* are probably Spicula Amoris. Their calcareous composition if coupled with a quadrangular outline would establish the fact. PAUL HENRY STOKOE

Beddington Park

Distribution of Black Rat

IT may interest Mr. Middleton to know that in 1866, the black rat was abundant on the top of the Island of Ascension; below, the "House of Hanover" held sway. I counted about a dozen, lying in a manure pit, that had been killed in the farm stables, during the previous two or three days, and was told by a soldier, who did not think them anything out of the way, that "there were plenty of them." E. L. LAYARD

Noumea, May 31

ON THE STRUCTURE OF THE STYLASTERIDÆ: A FAMILY OF HYDROID STONY CORALS[1]

UNTIL the late Prof. Agassiz in 1859 announced his discovery that the Milleporidæ were Hydroids and not Anthozoans, it was confidently believed that all living recent stony corals were most closely allied in their essential structure to the common sea anemones of our coasts. The majority of stony corals still remain under the old category. The beautiful calcareous branched or variously formed objects so familiar as ornaments or as exhibits in museums are nearly all of them formed within the bodies of animals which differ in no important features from the flower-like anemones of our aquariums. The sea anemones have no hard skeleton to support their soft and yielding bodies; the corals differ from them in that they have such skeletons. These are, during the life of the animals of which they form part, entirely embedded within the soft tissues, and only become exposed and appear in the familiar form when the animals are dead and their flesh has been removed from their bones by the action of decomposition or more speedy solution by means of caustic alkalis.

It seems difficult to explain how the popular error by which corals are spoken of as structures built up by coral "insects" arose. It is still perpetuated with considerable misleading detail in some schoolroom books, and it is quite common to meet still with educated persons who regard coral as analogous to honeycomb, and look upon it as built up by the "insects" in much the same sort of way.

Very many corals are solitary or simple, being the skeletons of single animals. As an example may be cited the mushroom-coral, the common chimney ornament, which is the largest known simple coral. This is the skeleton of a single animal comparable with and closely allied to a sea anemone. By far the greater number of forms of corals are, however, compound; that is to say, they are the skeletons of colonies of animals, each comparable to a single mushroom coral but living united together for mutual benefit and with their skeletons fused together to form a common support. Such are for example the various branched Madreporas and other similar forms, and the brain-corals so often brought home from the tropics by sailors.

Until Prof. Agassiz made the discovery above alluded to it was supposed that all stony corals were, as above described, Anthozoan. He found, however, to the astonishment of naturalists, that the corals known as the Milleporidæ were the skeletons of animals allied not to the sea anemones, but to the jelly-fish or Medusæ and the common Hydra of our fresh-water ponds and ditches. The Milleporidæ, of which there are very many species, which, however, fall within but a single genus, Millepora, are either branched and form shrub-like or antler-like masses of various sizes, or occur as irregular rounded lumps, often spreading in their growth over dead corals or other objects, and encrusting them. The Millepores are distin-

[1] The Croonian Lecture, 1878.

guished by the fineness and abundance of the minute pores by which the surfaces of their skeletons are pierced. The animals belonging to these corals had not been examined until they were investigated by Agassiz, and as he was not able to make any extended investigation of their structure, his results were long accepted by many naturalists with considerable hesitation. During the voyage of H.M.S. *Challenger* I studied the structure of several species of Millepora in detail, with the result of confirming Prof. Agassiz's results and yielding a detailed account of the minute structure of these organisms, which is almost complete, excepting with regard to their generative organs, which remain as yet entirely unknown.

In pursuing my observations on corals, I discovered that another family of stony corals, as well as the Milleporidæ, is also Hydroid in structure. This is the family of the Stylasteridæ, an account of the structure of which was selected by the Royal Society as the Croonian lecture for last year, and has just appeared in the new volume of the *Philosophical Transactions.* In the present article I have brought together the principal results of interest which are stated in detail in the lecture.

One of the Stylasteridæ (Allopora) had previously been examined in the living condition by Prof. G. O. Sars, and Sars had suspected that this coral might be Hydroid like the Milleporidæ, but he had been unable to work out the details of the structure of the organism and to prove the matter with certainty. Several observers, the late Dr. Gray, Prof. Verrill, and the Count de Pourtales, had observed the distinctness of the Stylasteridæ, and noticed that there were remarkable peculiarities characterising this family of corals.

The Hydroid stony corals, the Milleporidæ and Stylasteridæ, I have placed in a special sub-order, the Hydrocorallinæ. Though the two families are well distinguished from one another, they show many close resemblances in structure.

Amongst the Hydrocorallinæ there do not exist, as there do amongst the Anthozoan corals, any simple or solitary species; there are no Hydroid corals comparable thus to the mushroom corals, the only forms known are compound colonies. In the case of the Anthozoan corals it seems probable that in the progress of development a simple ancestral form derived from a sea-anemone developed a calcareous skeleton, and that from this solitary form compound corals were derived as subsequent modifications; or, rather, it is not unlikely that several solitary ancestors developed calcareous skeletons independently, and that from each of them different compound forms resulted. In the case of the Hydrocorallinæ, on the other hand, it seems probable that the calcareous skeleton was first developed as a support to already formed colonies, and that no solitary ancestor with a calcareous support preceded them.

Almost all the recent Anthozoan corals belong to the Hexactinia or corals which, like the common sea anemones, have the radially disposed soft structures of their bodies and the corresponding radial plates of their skeletons arranged in multiples of the number six. These Hexactinian Anthozoan corals are termed the Madreporaria. It is a very remarkable f ct that amongst all the vast number of species of compo d Madreporaria known, there seems to exist no instance of a modification of certain of the animals composing the colonies by a subdivision of labour amongst them for the general good to the colony. Amongst Alcyonarian corals and Hydroid corals such a sub-division of labour exists, but for some reason or other such high specialisation seems never to have been attained amongst Madreporaria.

In the case of the Hydrocorallinæ, the subdivision of labour amongst the members of the colonies is carried to a most interesting perfection. It reaches considerable completeness in the Milleporidæ, but in the more advanced Stylasteridæ attains a most elaborate complexity.

In all the Hydrocorallinæ the hard skeleton is very porous, being traversed in all directions by canals which branch and join one another in all directions. Within these canals are lodged corresponding branching and anastomosing tubes composed of soft tissues, which form a complex meshwork within the coral mass, and convey a general circulation common to all the members of the colony. In all the Hydrocorallinæ two kinds of polyps or zooids occur. The more numerous kind are devoid of any mouth or stomach, and act simply as catchers of food for the colony. These are hence termed dactylozooids. The less numerous kind have each a mouth and stomach, and are hence termed gastrozooids; they receive the food from the dactylozooids, and swallow it, and their bases being in direct communication with the general circulation, they nourish with the results of their digestion the dactylozooids and all the component parts of their colony.

In the Milleporidæ the dactylozooids, when expanded, are long and slender, and are provided all along their lengths with short tentacles each of which bears a knob at its end. In the case of the Stylasteridæ, however, the dactylozooids have quite lost their tentacles, and are simply long, slender, tapering bodies, reduced to the aspect of simple tentacles themselves. In the Milleporidæ the gastrozooids are provided with short tentacles round their mouths, and such tentacles are also present in the case of the gastrozooids of most of the genera of Stylasteridæ, the number present varying in the case of each genus. In some genera of Stylasteridæ, however, even the gastrozooids have lost their tentacles, and remain as simple cylindrical digestive sacs; in these instances the entire colonies are devoid of tentacles altogether.

The zooids are lodged within pits or pores on the surfaces of the corals, which are termed gastropores or dactylopores, according to the kind of zooid belonging to them. The gastropores are larger than the dactylopores in correspondence with the size of the respective zooids. In most species of Millepora and several genera of Stylasteridæ the gastropores and dactylopores, intermingled with one another, are scattered irregularly all over the surfaces of the corals; but in one species of Millepora occurring at Tahiti the pores are gathered with some considerable regularity into circular groups, each of which is composed of a single centrally-placed gastropore and a surrounding zone of six or seven dactylopores. In this case the zone of dactylozooids in each group or system ministers to the wants of the single gastrozooid of that system.

The complexity of relations of the zooids advances no further in the case of the Milleporidæ, but in that of the Stylasteridæ many additional complications exist. In several genera (*Allopora*, *Stylaster*, *Cryptohelia*, *Astylus*) the pores occur only in regular circular systems, which are termed cyclosystems. In each of these cyclosystems there is a deep centrally-placed gastropore and a circular zone of from five to upwards of twenty dactylopores. The mouths of the dactylopores, instead of being circular in outline, are drawn out into the forms of long slits, which are disposed in the cyclosystems in a regular radial manner towards the central gastropore. In species in which the dactylopores are numerous and closely packed in the systems, a thin wall only of hard coral skeleton is left intervening between them. Hence each system has closely the appearance of an ordinary Anthozoon coral cup, with its radiating septal plates, and so close is the resemblance that Gray and all earlier observers did not doubt that Stylaster and its allies were essentially similar in structure to the ordinary branching corals, such as Oculina.

The essential difference between a cyclosystem of a Stylasterid and an Anthozoan coral cup is, however, as wide as possible. The radiating plates in the case of the Anthozoan coral are skeletal structures developed

within the body of a single polyp, whereas the so similar-looking radiating plates in the case of the cyclosystem are skeletal plates developed outside the bodies of the numerous component polyps altogether, and separating a number of adjacent polyps from one another. The peculiar radiate form of the cyclosystems of the Stylasterids has no doubt been gradually developed as the result of the constant bending inwards of the dactylozooids in each system to reach their gastrozooid when further and further retracted within its pore. The dactylozooids have thus in course of generations pulled the mouths of their pores out into the form of slits all directed inwards towards the gastropore in each system. In the case of some genera the gastrozooids have carried matters so far that they have ceased to be retracted within their own pores when at rest, but double themselves inwards for safety within the wide mouths of their gastropores. In one genus (Cryptohelia) a further protection is afforded to the zooids by the growth in front of each system of a delicate lid-like lamina of hard coral skeleton, which projects in front, and shields all the zooids when retracted.

In some genera of Stylasteridæ the zooids are not gathered into cyclosystems at all, but various other complications occur. Thus, in some genera there are two kinds of dactylozooids, larger and smaller. The larger and longer, in order to gain more reach in procuring food, are borne at the tips of long spine-like projections of the hard skeletons of the corals, whilst the smaller dactylozooids are lodged in small pores at the bases of these spines where they are in close proximity to the gastrozooids. The larger dactylozooids presumably catch the food, and are helped in delivering it to the gastrozooids by their shorter companions.

As before stated, the mode of generation of the Milleporidæ is as yet unknown, but it is certain that it differs in one important particular from that of the Stylasteridæ. In these latter small cavities, or brood pouches, termed ampullæ, are formed in the hard skeleton of the coral, and in these the generative elements are developed. Each coral stock is of separate sex, all its components being either male or female. The walls of the ampullæ in many cases project above the surfaces of the corals, and are especially prominent in female stocks, since they have in these cases to contain large embryos. In some specimens of Stylasteridæ the ampullæ are very conspicuous to the naked eye, looking like small convex blisters closely packed on the surfaces of the coral branches. They are particularly well marked in the case of female stocks of species of Distichopora, which are thus especially serviceable for class demonstration, and when the generative function of the ampullæ is premised, afford evidence at a glance of the hydroid nature of the Stylasteridæ. The ova are developed within the ampullæ to the condition of mature planulæ, when they are set free by the gradual thinning and final rupture of the ampullar walls and swim off to start fresh colonies. It is highly probable that the masses of tissue from which the ova are developed, and which protect them during growth, are representatives of polyps, which have, like the dactylozooids, lost their mouths, and have come by restriction of function to be mere egg-bags as it were.

In all the Stylasteridæ, even those with very complex cyclosystems, there is a complete circulatory connection between the different systems and all parts of the colony, as well as amongst the components of each system. Thus in these complex mutual benefit associations, certain members of the colonies catch the food, but do not eat it, others receive it from them and nourish the whole colony thereby, whilst others again neither catch food nor eat it, but devote themselves entirely to the production and rearing of the young.

The ancestral forms from which the Hydrocorallinæ have been developed must have been colonies closely similar in essential structure to their present descendants, but with all their component zooids provided with mouths and generative organs, all alike catching food and digesting it, and possibly all taking their share in the production of young. In such colonies further development may be conceived of as having arisen by either of two processes. All the zooids may have become gradually modified, so that each performed only one function and thus had certain of its structures aborted to fit it for this special end. If such be the history of the development of the Hydrocorallinæ then the dactylozooids are to be looked on as they have been regarded throughout this paper as representatives of zooids which in the ancestral condition were provided with a mouth and stomach, but in which these structures as well as the generative structures have become rudimentary by disuse. Similarly in the case of the gasterozooids the functions of prehension have to a large extent been lost, and the zooids have become, in some cases, mere stomachs.

On the other hand the view may be taken that the gastrozooids alone represent the original zooids of the ancestral colony. They remain, having lost their generative organs and to a greater or less extent their prehensile ones because additional zooids have been formed by budding in order to provide for the wants of the colony in these particulars. On this view the generative zooids and dactylozooids were originally budded out in the condition in which they now exist or in one not so complete as it is at present, nor so perfectly adapted to their present function. On this view they have lost no structure by disuse, but have rather advanced in complexity with development but only in their own specialised direction.

The former view of the antecedent history of the suborder Hydrocorallinæ has been here adopted, because the presence of several structures which occur as rudiments in connection with the dactylozoids and generative zooids, but which are fully developed in connection with the gastrozooids, seem to bear out this conclusion. As examples may be cited the calcareous styles which gave the name to the family Stylasteridæ. These styles are small projections of the hard skeletons of the corals which support the gastrozooids within their pores. In several genera rudimentary styles are found to occur in connection with the dactylozooids.

The Stylasteridæ, in the complexity of their compound stocks, form an interesting parallel to the Siphonophora. In the Siphonophora the several components of the compound organisms are by the best authorities regarded not as individual zooids, but as portions of the organisms which, being budded out, tend in their growth to assume more and more the form of individuals. The question is to some extent one of nomenclature, but it must not be forgotten that though the diverse elements composing the organism in the case of the Siphonophora may seem closely paralleled by those of which that of a Stylasterid is made up, the past history of the two organisms may be very different. In the one case an ancestral already compound organism may have gradually modified its similar zooids to subserve division of labour, whilst in the other a simple ancestor may have gradually developed a similar compound organism by throwing out buds of various forms, which have come more or less to approach itself in complexity. H. N. MOSELEY

IRIDO-PLATINUM

THE volume of the *procès-verbaux* of the International Commission of Weights and Measures published in Paris last year,[1] contains, among other matter of much value, an interesting appendix by MM. Sainte-Claire Deville and Stas, who were requested by the Commission to ascertain the composition of the platinum-iridium alloy employed in the preparation of the rules and cylinders

[1] Gauthier-Villars. Paris, 1878.

destined to serve as the International Prototype Standards. Their investigations are set forth at great length, and analytical chemistry is thus enriched by an elaborate memoir, in every way worthy of its distinguished authors. The alloys of platinum iridium, of which these standards are made, was furnished by Mr. George Matthey, of the well-known firm of Johnson, Matthey, and Co., and, in the April number of the *Annales de Chimie*, there is a paper by MM. Deville and Mascart, describing the experimental determinations of the various physical constants of the metal of which the Règle Géodésique is made. We cannot do better than quote their words as indicating the care and skill bestowed by Mr. Matthey in the preparation of this standard: "En fabriquant un pareil alliage avec une telle pureté, M. Matthey a résolu un problème de métallurgie des plus difficiles et des plus compliqués. On ne peut s'imaginer, à moins qu'on ne connaisse dans tous leurs détails les procédés si pénibles employés à la purification de l'iridium et même du platine, combien il a fallu d'intelligence, de patience et de dévouement à la Science pour réussir dans une pareille œuvre." [1]

As the matter is of much importance, a paper recently communicated to the Royal Society by Mr. G. Matthey possesses special interest, as in it he describes the methods employed for preparing the metals in a state of purity. The following is an abstract:—

"The six metals (of which platinum is the chief) usually found more or less in association, present characteristics of interest beyond their metallurgical utility, which are, perhaps, worth alluding to. It is, for instance, a curious fact that the group should consist of three light and three heavy metals, each division being of approximately the same specific gravity—the heavier having (in round figures) just double the density of the lighter series.

Thus we find osmium, iridium, platinum forming the first division, of the respective specific gravities of 22·43, 22·39, 21·46; whilst ruthenium, rhodium, and palladium are represented by the figures 11·40, 11·36, 11, the average densities of the heavy and light divisions thus being respectively 22·43 and 11·25.

But a more interesting and important classification is what I may designate as a first and second class series, from the more important view of their relative properties of stability. Thus platinum, palladium, and rhodium form the first or higher class, not being volatilisable in a state of oxide; iridium, osmium, and ruthenium forming the second or lower class, their oxides being more or less readily volatilised.

The oxide of iridium is affected at 700° to 800° C., and entirely decomposed at 1,000°, whilst osmic and hypo-ruthenic acids are volatilised at the low degree of 100°, the latter exploding at 108°. The chlorides of these metals can be sublimed at different temperatures (as also the protochloride of platinum).

Platinum

The preparation of this metal in a state of purity is an operation of extreme delicacy. I commence by taking ordinary commercial platinum; I melt this with six times its weight of lead of ascertained purity, and, after granulation, dissolve slowly in nitric acid diluted in the proportion of 1 volume to 8 of distilled water. The more readily to insure dissolution, it is well to place the granulated alloy in porcelain baskets such as are used in the manufacture of chlorine gas for holding the oxide of manganese. When the first charge of acid is sufficiently saturated, a fresh quantity should be added until no more action is apparent; at this stage the greater part of the lead will have been dissolved out, together with a portion of any copper, iron, palladium, or rhodium that may have been present. These metals are subsequently extracted from the mother-liquors, the nitrate of lead by crystallisation, and the remaining metals by well-known methods.

[1] *Ann. de Chim. et de Phys.*, 5me Série, t. xvi., April, 1879.

The metallic residue now obtained will be found in the state of an amorphous black powder (a form most suitable for further treatment), consisting of platinum, lead, and small proportions of the other metals originally present—the iridium existing as a brilliant crystalline substance insoluble in nitric acid. After digesting this compound in weak aqua regia, an immediate dissolution takes place of the platinum and lead, leaving the iridium still impure, but effecting a complete separation of the platinum.

To the chloride of platinum and lead after evaporation is added sufficient sulphuric acid to effect the precipitation of the whole of the lead as a sulphate, and the chloride of platinum, after dissolution in distilled water, is treated with an excess of chloride of ammonium and sodium, the excess being necessary in order that the precipitated yellow double salt may remain in a saturated solution of the precipitant. The whole is then heated to about 80°, and allowed to stand for some days; the ammonio-chloride of platinum will settle down as a firm deposit at the bottom of the vessel, whilst if any rhodium, as is generally the case, is present, the surface liquor will be coloured a rose tint, occasioned by a combination of the salts of the two metals.

The precipitate must be repeatedly washed with a saturated solution of chloride of ammonium and subsequently with distilled water charged with pure hydrochloric acid. This is necessary for its purification. The small quantity of the double salt which will be taken up and held in solution is of course recovered afterwards. Rhodium may still exist in the washed precipitate, which must therefore not be reduced to the metallic state until its separation is completed, and this is best effected by mixing with the dried compound salts of chloro-platinate and chloro-rhodiate of ammonia, bi-sulphate of potash with a small proportion of bi-sulphate of ammonia, and subjecting to a gradual heat brought by degrees up to a dull red in a platinum capsule, over which is placed an inverted glass funnel. The platinum is thus slowly reduced to a black spongy porous condition freed from water, nitrogen, sulphate of ammonia, and hydrocloric acid, the rhodium remaining in a soluble state as bi-sulphate of rhodium and potash, which can be dissolved out completely by digesting in boiling distilled water; a small quantity of platinum will have been taken up in the state of sulphate, but is regained by heating the residue (obtained on evaporation) to redness, which reduces it to the metallic condition, the rhodium salt remaining undecomposed.

By the method above described the platinum is freed not only from rhodium, but from all other metals with which it may have been contaminated, and is brought to a state of absolute purity, of the density 21·46, the highest degree obtainable.

Iridium

In practice, the purest iridium which can be obtained from its ordinary solution (deprived of osmium by long boiling in aqua regia and precipitated by chloride of ammonium) will almost invariably contain traces of platinum, rhodium, ruthenium, and iron.

I fuse such iridium in a fine state of division with ten times its weight of lead, keeping it in a molten state for some hours, dissolve out the lead with nitric acid, subject the residue to a prolonged digestion in aqua regia, and obtain a crystalline mass composed of iridium, rhodium, ruthenium, and iron, in a condition suitable for my further treatment. By fusion at a high temperature with an admixture of bi-sulphate of potash, the rhodium is almost entirely removed, any remaining trace being taken up together with the iron in a later operation. The iridium so far prepared is melted with ten times its weight of dry caustic potash, and three times its weight of nitre, in a gold pan or crucible; the process being prolonged for a considerable time to effect the complete transformation of

the material into iridiate and rhuthenate of potash, and the oxidation of the iron; when cold, the mixture is treated with cold distilled water. The iridiate of potash of a blue tinge will remain as a deposit almost insoluble in water, more especially if slightly alkaline, and also the oxide of iron.

This precipitate must be well washed with water charged with a little potash and hypochlorite of soda until the washings are no longer coloured, and then several times with distilled water.

The blue powder is then mixed with water strongly charged with hypochlorite of soda, and allowed to remain for a time cold, then warmed in a distilling vessel, and finally brought up to boiling point until the distillate no longer colours red, weak alcohol acidulated with hydrochloric acid.

The residue is again heated with nitre and potash water charged with hypochlorite of soda and chlorine, until the last trace of ruthenium has disappeared.

Further, to carry out the purification, the blue powder (oxide of iridium) is re-dissolved in aqua regia, evaporated to dryness, re-dissolved in water, and filtered.

The dark-coloured solution thus obtained is slowly poured into a concentrated solution of soda and mixed with hypochlorite of soda, and should remain as a clear solution without any perceptible precipitate, and subjected in a distilling apparatus to a stream of chlorine gas, should not show a trace of ruthenium when hydrochloric acid and alcohol are introduced into the receiver. In this operation the chlorine precipitates the greater part of the iridium in a state of blue oxide, which, after being collected, washed, and dried, is placed in a porcelain or glass tube, and subjected to the combined action of oxide of carbon and carbonic acid obtained by means of a mixture of oxalic with sulphuric acid gently heated.

The oxide of iridium is reduced by the action of the gas leaving the oxide of iron intact, the mass is then heated to redness with bi-sulphate of potash (which will take up the iron and any remaining trace of rhodium), and after subjecting it to many washings with distilled water, the residue is washed with chlorine water to remove any trace of gold, and finally with hydrofluoric acid, in order to take out any silica which might have been accidentally introduced with the alkalies employed or have come off the vessels used.

The iridium after calcination at a strong heat in a charcoal crucible, is melted into an ingot.

Alloy of Iridio-Platinum

Operating upon a charge of 450 ounces of platinum and 55 ounces of iridium, I commenced by melting these metals together and casting into an ingot of suitable shape, which I then cut into small pieces with hydraulic machinery. After re-melting and retaining in a molten condition under a powerful flame of oxygen and common gas for a considerable time, I re-cast and forged the mass at an intense white heat under a steam hammer, the highly-polished surfaces of which were cleaned and polished after each series of blows—when sufficiently reduced the alloy was passed through bright polished steel rollers, cut into narrow strips, and again slowly melted in a properly-shaped mould, in which it was allowed to cool. I thus obtained a mass of suitable shape for forging, perfectly solid, homogeneous, free from fissures or air-holes, and with a bright and clean surface.

A piece cut from the end of a mass so prepared, was presented to the French Academy of Science, and gave the following results:—

Weight in air	116·898 grms.
,, water	111·469 ,,
Showing a density of	21·516 ,,

thus proving that the necessary processes of annealing at a high temperature had caused it to resume its original density.

The analysis gave—

	1	2
Platinum	89·40	89·42
Iridium	10·16	10·22
Rhodium	0·18	0·16
Ruthenium	0·10	0·10
Iron	0·06	0·06
	99·90	99·96

From which is deduced:—

	Proportion.	Density at zero.	Volume.
Iridio-platinum at 10 per cent.	99·33	21·575	4·603
Iridium, in excess	0·23	22·380	0·010
Rhodium	0·18	12·000	0·015
Ruthenium	0·10	12·261	0·008
Iron	0·06	7·700	0·008
	99·90		4·644

Density at zero, calculated after No. 1 analysis	21·510
Density at zero, calculated after No. 2 ,,	21·515

which coincide perfectly with the practical results obtained."

MM. Deville and Mascart find the coefficient of dilatation to be from 0° to 16° C. 0·00002541.

As we have already pointed out, work on which the accuracy of standards depends is of the highest importance, and Mr. Matthey is therefore to be congratulated on the success of his labours.

THE INFLUENCE OF THE TRANSVERSE DIMENSIONS OF ORGAN PIPES ON THE PITCH

IN NATURE, vol. xix. p. 172, Mr. Ellis gives, on the authority of M. Cavaillé-Coll, a rule determining a point of some interest in regard to organ-pipes. All those who are accustomed to organs know that the theoretical rule which makes the vibration-number of the note sounded vary inversely as the length of the pipe, does not hold correctly in practice, as the pitch is influenced by the *transverse dimensions*. A pipe of "large scale," *i.e.*, of large diameter, will speak a lower note than one of "small scale," the length of the tube being in both cases the same. I am not aware that this fact has been explained in acoustical works, or any rule given for the variation.

Mr. Ellis's formula provides for this, so far as cylindrical pipes are concerned, and he has found it to agree well with experiment. There is a misprint in his equation, which at first sight renders it somewhat obscure, and in correcting this I will venture to present M. Cavaillé-Coll's investigation more completely, as it was expressed by him in a paper presented to the Academy of Sciences many years ago, and a copy of which he was good enough to give me.

After calling attention to the theoretical rule, he remarks that the departure from it is due to the influence of the *mouth* of the pipe, *i.e.*, the rectangular opening at the lower end of the tube. He made many experiments to determine the effect of this, and came at length to the result that in open pipes of rectangular section the *effective length of the pipe* was equal to the *length of the sound-wave* due to its note [or the half wave-length according to our mode of calculation] *diminished by twice the internal depth* of the tube. By the "depth" is meant the transverse dimension from front to back; the other transverse dimension, the *width*, appearing to be of no consequence.

Thus, if S represent the velocity of sound, V the number of vibrations per second (*single* ones, according to the French mode of calculation), L the length of the pipe, taken from the lower edge of the mouth to the end of the tube; and P the internal transverse depth, then—

$$L = \frac{S}{V} - 2P.$$

M. Cavaillé-Coll gives two examples of applications he made of this formula :—

1. A wood pipe sounding what is called 4-foot C, 264 [single] vibrations per second at the normal French pitch, and having a depth of 8 centimetres, was found to have a length of $1^{m} \cdot 13$. Taking the velocity of sound at 10° to 15° C. to be 340 metres per second, the equation would give—

$$\frac{340}{264} - 0{\cdot}16 = 1^{m}{\cdot}128,$$

differing only 2 millimetres from that actually found.

2. The large 32-foot pedal pipe of the organ of St. Denis was at first cut to a length of $9^{m} \cdot 566$, the internal depth being $0^{m} \cdot 48$. The number of single vibrations per second was intended, according to the standard pitch, to be 33, according to which the equation gave—

$$\frac{340}{33} - 0{\cdot}96 = 9^{m}{\cdot}36$$

as the calculated length. This showed the pipe to be too long, which proved to be the fact, the note being too flat. An opening was then made to reduce the effective length to that given, when the pipe was found to be in perfect tune.

In applying the formula to *cylindrical* pipes, M. Cavaillé-Coll found the same law obtain; allowing for the difference in shape, and for the flattening of the pipe necessary to form the mouth properly, he considered that the mean depth was about equal to five-sixths the diameter, or—

$$P = \frac{5}{6} D.$$

Substituting this in the above equation it becomes, for cylindrical pipes—

$$L = \frac{S}{V} - \frac{5}{3} D.$$

Taking now the mean velocity of sound given by M. Cavaillé-Coll, namely, 340 metres or 1115 feet per second; putting the dimensions of the pipe in inches, and altering V to represent the number of *double* vibrations per second, according to our English custom; we obtain, finally, for cylindrical pipes—

$$L = \frac{6690}{V} - \frac{5}{3} D; \text{ or}$$

$$V = \frac{20070}{3L + 5D}.$$

Mr. Ellis's rule is—

$$V = \frac{20080}{3L + 5V}.$$

the letter V, however, in the denominator being clearly a misprint for D.

The foregoing rules, it must be stated, apply to pipes *open at the end*, which constitute the great bulk of those in an organ. WILLIAM POLE

GEOGRAPHICAL NOTES

THE letter from Sir Rutherford Alcock in yesterday's *Times*, announcing the death of Mr. Keith Johnston, will be received with surprise and sincere regret. As our readers know, Mr. Johnston was leading the Geographical Society's expedition from Dar-es-Salaam to the north end of Lake Nyassa, and, if possible, thence to Tanganyika. A start was made on May 14, and now the sad news comes that the young leader died of dysentery on June 28, at Berobero, about 130 miles inland. Mr. Johnston came of a famous geographical house, and had already done good exploring work in South America. He was enthusiastic on the matter of African exploration, and was well qualified to carry it out in a scientific method. His death is a real loss to scientific geography. We are glad to learn that the expedition will be continued under the leadership of Mr. Thomson, the geologist who accompanied Mr. Johnston.

IT is with great pleasure we learn from a letter of Dr. G. Nachtigal to the editor of Petermann's *Mittheilungen*, that the announcement of Dr. G. Rohlfs' retirement from the leadership of the expedition of the German African Society was premature. He did express a wish to resign, but has since been able to overcome all initiatory difficulties, and left Benghazi with his followers on July 4, and it is hoped will be able to reach Abesh, the chief town of Wadai, about the middle of next month. Dr. Nachtigal's account of his own great exploring work in North and Central Africa from 1869 to 1874 has just been published in Berlin.

AT the last sitting of the Paris Geographical Society, M. Paul de Soleillet explained his scheme for putting Timbuctu in communication with the Atlantic. A railway must be made from Dakkar, on the Atlantic coast and St. Louis, the head city of French Senegal. This work will be begun next winter. The Senegal must be rendered navigable from St. Louis to Bafoulabé, and a canal constructed from Bafoulabé to Bamakou, on the Niger. These projects having been adopted by the High Commission, the Survey for the canal will begin immediately. The Niger is navigable without works of any description from Bamakou to Timbuctu and other places below for a distance of 1,500 miles. The aggregate expense required for the whole of the work is estimated at a million sterling, and the number of people placed in close connection with French Senegal thirty-seven millions. A M. Fourreau has sent a letter to the President of the Society stating that he, with two friends, had established a farm in Oued Bish, about 150 miles southward of Biskra, in the direction of the intended Transaharian Railway *viâ* Biskra. The exploration committee of the Saharan Railway Commission has recommended the Government to send out M. Soleillet to visit the unexplored regions between 15° and 25° N. lat.

TAKEN as a whole, the August number of the Geographical Society's monthly periodical appears to be the best that has been issued. The papers are Major Serpa Pinto's notes of his journey across Africa ; Mr. McCarthy's "Across China, from Chinkiang to Bhamo;" and the late Capt. R. R. Patterson's notes on Matabeli-land. The map of South Africa, accompanying Major Pinto's notes, is particularly interesting, as it embodies a good deal of original information. The geographical notes are unusually full and varied, and we are glad to observe that greater attention is being paid to this most essential department of a geographical magazine. Since the note on Major Tanner's exploratory visit to Kafiristan was written, news has unfortunately arrived that ill-health has compelled that officer to return to India. There is a useful summary of Dorandt's report, published by the Russian Geographical Society, on his astronomical and magnetic observations on the Lower Oxus, and of Mr. Hillier's account of his journey in North China at the beginning of this year. Climatology also claims a place among the notes. The remainder of the number is occupied with a report of the evening meetings, the proceedings of foreign societies, and notes on new books and maps.

NEWS has just been received at Copenhagen from the scientific expedition which sailed for Greenland in the *Ceres* on March 29 last. The expedition, which consists of two naval officers, MM. Jansen and R. Hammer, and a student of polytechnics, M. Kornerup, reached the Holsteinborg Colony, in Greenland, on April 30, and at once proceeded with their investigation and measurement of the coast and fjords between Holsteinborg and Egedesminde. They left the neighbourhood of Holsteinborg on May 15, travelling in small Greenland boats. From that date to the end of August, when they hope to reach Egedesminde, the explorers will have to camp in their boats or on the rocky shore. However, the summer nights are bright in those latitudes, and the expedition is well equipped with all necessaries.

ELECTRICAL CLOCKS AND CLOCKWORK

IN the year 1843 an electrical pendulum which forms the basis of nearly all succeeding systems of electrical clockwork, was patented by the late Alexander Bain. (See Fig. 1.)

The bob of the pendulum, C, consists of a coil of insulated wire. One end of the wire passes to the axis of the tumbler A T, the other, through the suspension spring S, to the plate P_1. P_1 P_2 are plates, say of zinc and carbon, and are sunk in the earth to form the battery. From P_2 a wire W_2 proceeds to N. MM is a horse-shoe magnet. Whilst AT leans against N, a current is passing, and C is magnetic. C has its − and + poles facing the + and − poles of the horse-shoe magnet. Consequently the pendulum is driven to the left, but when it reaches a certain point, AT topples over, the current ceases, and the pendulum returns. The pendulum now proceeds on its swing to the right, but on approaching the limit of its oscillation, overturns AT again, the current is renewed, and the pendulum again propelled to the left. This action automatically repeats itself. Mr. Bain placed within the circuit of his pendulum any number of electrical dials. Fig. 2 shows the mechanism of these. C is a coil either in the line of W_1 or W_2. When a current passes C becomes magnetic, and oscillates between the magnets MM. At every swing of C a tooth, T_1, of the wheel is gathered up by the detent DD. The click, KK, by holding a tooth, T_2, prevents the wheel returning whilst D is passing to the right.

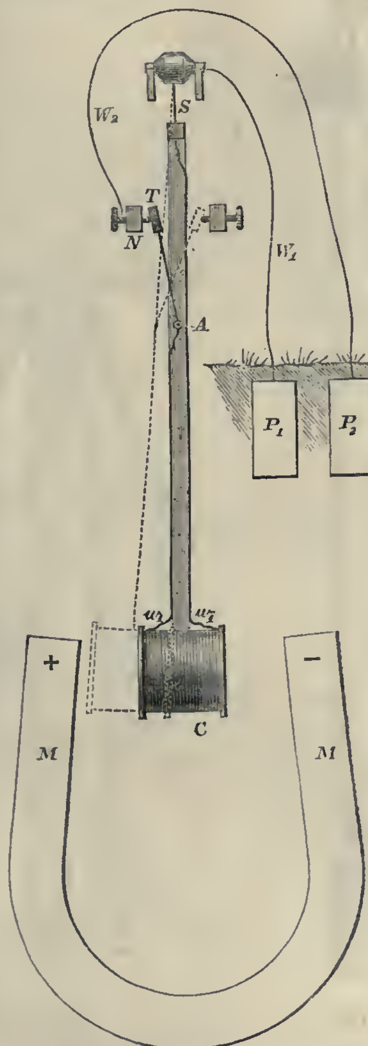


FIG. 1.

The impulse on Mr. Bain's pendulum varied with the power of his battery, a condition fatal to good time-keeping. In 1849 Mr. Shepherd patented a system in which the current was employed to lift a slight weight or spring. The fall of this propelled his pendulum, and gave an impulse quite independent of any variation in the power of his battery. Fig. 3 shows one of his plans.

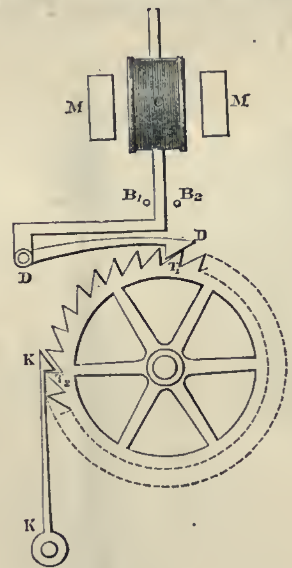


FIG. 2.

PP is the pendulum, W a weight, mounted on a lever WCA. WCA can move about a centre C, and is at present prevented from turning by the catch SS. When PP swings to the right, the lower screw in PP passes under E (see side view Z) and frees WCA. WCA, under the weight of W, propels the pendulum to the left till stopped by a banking B. PP moves on and makes contact with T, whereupon a current passes, M_1 M_2 become magnetised, and attract LL, the vertical arm of which lifts WCA over the catch SS again. When PP leaves T the current ceases, and LL is carried back to its old position by the action of the spring R.

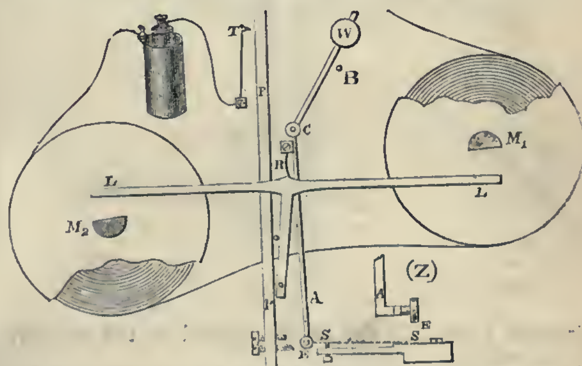


FIG. 3.

Mr. Bain's and Mr. Shepherd's are the leading types of electrical clocks properly so called, that is to say, of clocks which keep themselves going by electricity. But it

is scarcely worth while to use electricity when you can get gravity more cheaply. And do what you will, you can never absolutely rely on getting your current when you want it. For these reasons purely electrical clocks are very seldom used, it being found better to do whatever electrical work is required, by an ordinary clock with galvanic contact apparatus affixed. But though electrical clocks pure and simple have not made much progress, the system of *controlling* a quantity of indifferent clocks from one good one has. This principle was invented by Mr. Jones, of Chester, and Fig. 4 shows it.

(3) is the pendulum of the controlling clock, and (2) that of a controlled clock; (1) is a side view of (2). C, the bob of (2) is a hollow coil of insulated wire, and swings over two magnets, M_1 M_2, which have their similar poles facing each other. The ends of the wire forming C are carried up the pendulum, pass respectively through S_1 S_2, and terminate in T_1 T_2. T_1 is joined to T, which crowns the pendulum of the controlling clock, and T_2 is in connection with both N_1 N_2, the contact springs of the same. Both N_1 N_2 have their respective batteries, B_1 B_2, but with opposite poles towards J; so that if C is magnetised in one

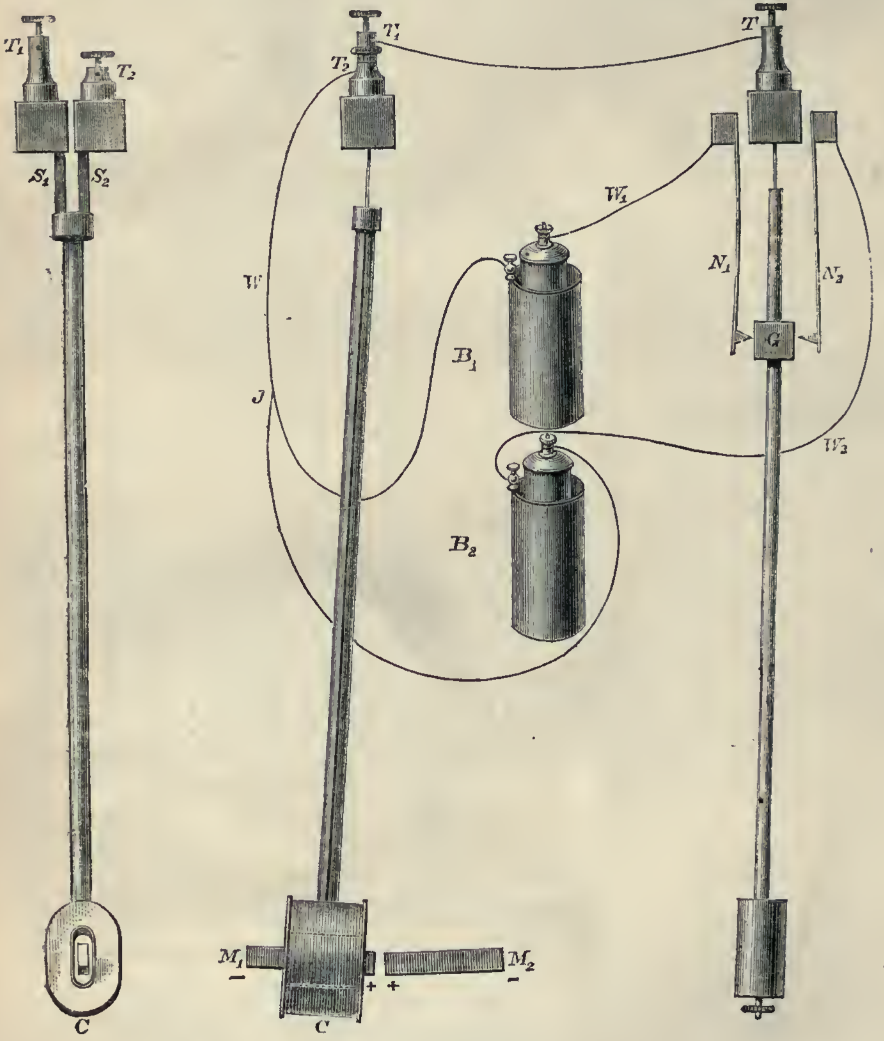


FIG. 4.

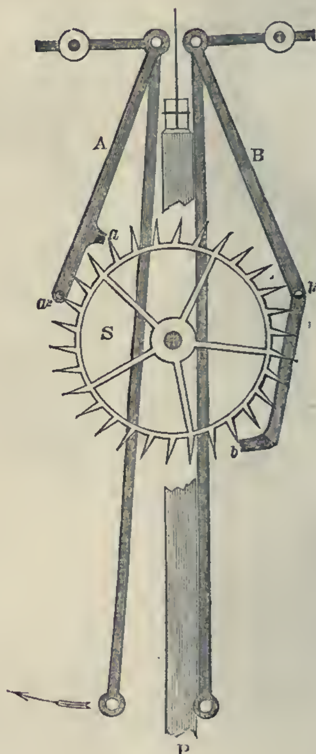


FIG. 5.

direction by one, it will be magnetised in the opposite by the other.

Suppose (2) has a tendency to lag as compared with (3). When (3) approaches the extremity of its swing, G meets N_1, a current passes, C is magnetised and is pulled on smartly. When G leaves N_1, the current ceases. G goes to meet N_2, then C, which is now over M_2, is again magnetised, but in the reverse direction. M_2 being also reversed as regards M_1, C, if behind, is pulled on again. Should (2) be in front of (3) its motion would be checked. A great many clocks can by this method be kept swinging in unison together.

Mr. Ritchie, of 25, Leith Street, Edinburgh, has patented an ingenious modification of the above. He places in the circuit of his controlling clock not other clocks, but pendulums. These he drives in just the same way as Mr. Jones controls his, and each pendulum works a train of wheels which move hands. Mr. Ritchie's are really electrical dials, but they have this great advantage, that should the current fail, as currents are apt to occasionally, the momentum of the pendulums is sufficient to keep the dials moving for a short time independently of it. The method by which the pendulums drive the wheel work is interesting (see Fig. 5).

A and B, the pallets, swing loose. S, the escape wheel, is now being held against a_2, a stop on A, by the weight of

B, which is pressing the tooth b. B has been deposited on b by the pendulum P, which is swinging to the left. Presently the pendulum lifts the vertical arm of A, and unlocks the wheel. The wheel moves on, but B falls, and the stop b_2 on B catches the tooth which is just above it. The pendulum continues its swing, and on returning, deposits A on the next succeeding tooth to a. It then proceeds to B, and continues the performance as before.

It is desirable that you should know that all your controlled or driven clocks are performing properly. In the circuit, alongside the standard clock, a galvanometer is

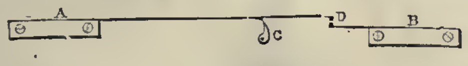


FIG. 6.

placed, and each of the controlled or driven clocks is fitted with the following mechanism (see Fig. 6).

A D, D B are two springs through which the current passes. C is a lifter upon the axis of the escape wheel of one of the controlled or driven clocks. Every minute C comes round and breaks the circuit for one second, and anybody standing at the controlling clock, knows when this happens by the needle of the galvanometer remaining stationary. We arrange, for instance, that clocks A, B, C, D shall cut out respectively the 3rd, 9th, 15th, and 40th seconds, and if these seconds are regularly cut out, we know that our controlled clocks are running with the standard.

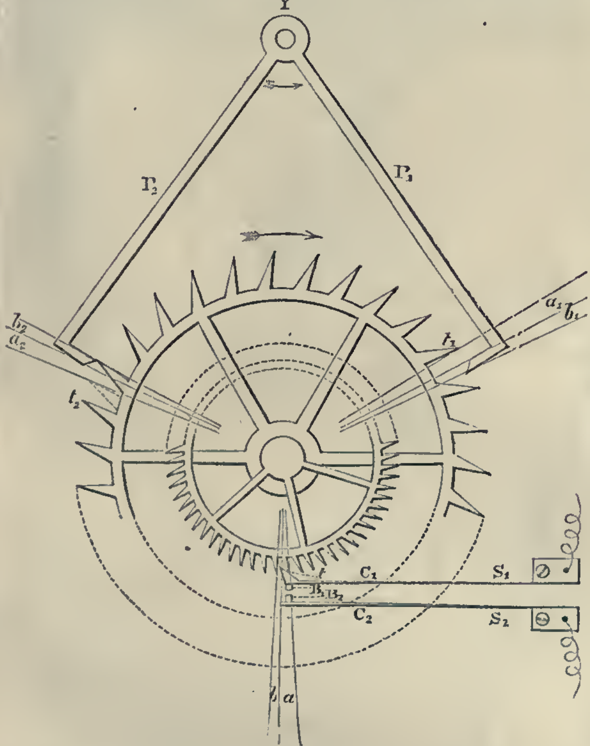


FIG. 7.

It is a matter of importance that the system of making electrical contact shall disturb the pendulum as slightly as possible. The method described above (by the two springs N_1 N_2) would scarcely suffice, when the most accurate timekeeping was required. The standard sidereal clock at Greenwich has a jewelled pin in the crutch rod which in passing zero presses two weak springs together. A better plan (Mr. Hartnup we are informed had also previously used it) seems one which has just been constructed by Messrs. Dent for some other work. In this it would appear that the resistance of the contact springs cannot affect the pendulum at all; because the springs are lifted during the drop of the escape wheel from one pallet to the other (see Fig. 7).

A tooth has just passed from the impulse face of the

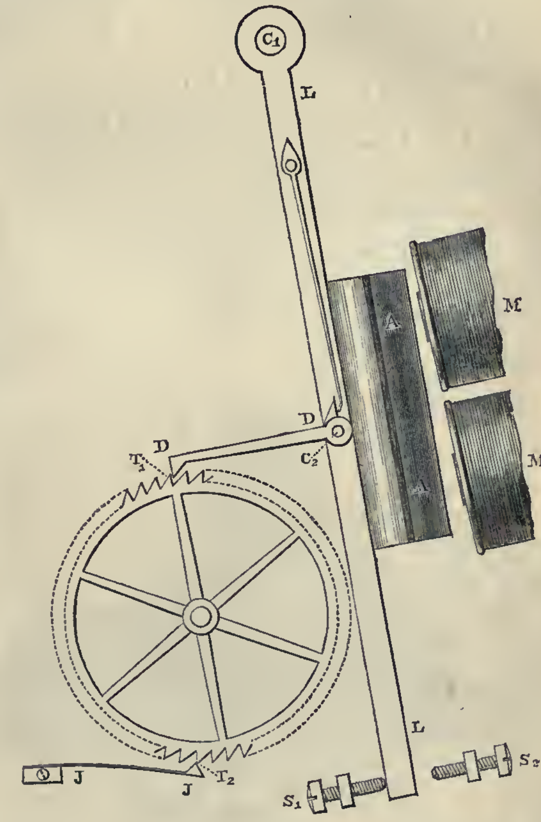


FIG. 8.

pallet P_2; t_1 now falls through the angle a_1 on to the dead face of the pallet P_1. *During this interval* the tooth t of the smaller wheel mounted on the same axis as the escape

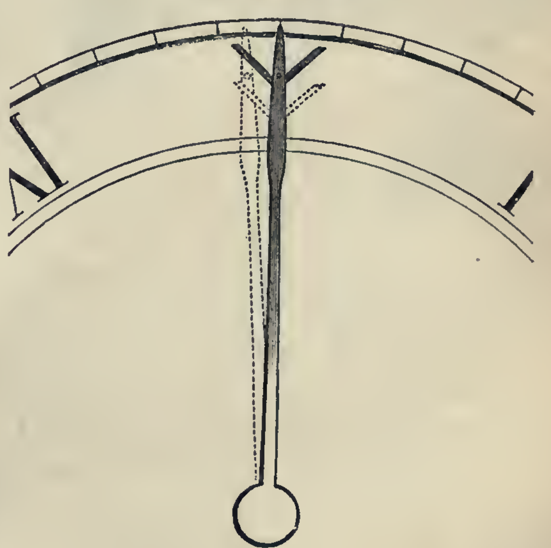


FIG. 9.

wheel lifts the contact spring C_1 S_1 against the contact spring C_2 S_2, and the current passes. It will be seen that when the tooth t_1 goes on to give impulse to the pallet

P_1 through the angle b_1, the tooth t has allowed the springs to drop, and that it travels through its corresponding angle b perfectly undisturbed. The motion of the tooth t_2 can easily be traced from the drawing. Careful workmanship is required to carry out this method properly, as the angles a, a_1, a_2 ought to be made much smaller than in the drawing.

Fig. 8 shows some electrical dial work.

M M are coils, A A is an armature, L L a lever turning about C. D D is mounted on L L and kept in position by a spring. J J is a jumper. As soon as a current ceases, L L, which has been attracted by M M, falls, and D D drives forward a tooth, T_1. When D D reaches the limit of its thrust, the point of J J just gets round the corner of T_2, and drives on T_2, makes it jump a little further. The jumper seems a better arrangement than the usual ratchet.

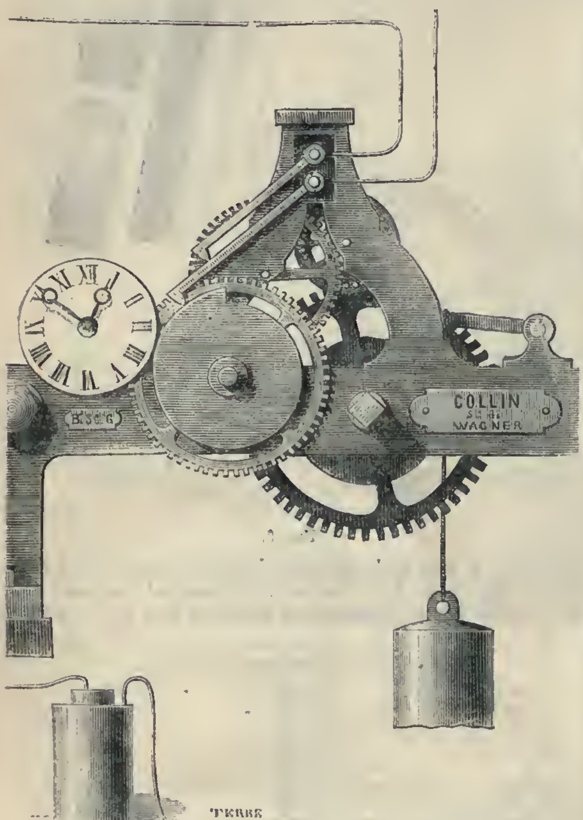


Fig. 10.

It has become popular of late to set the hands of indifferent clocks by electricity. This plan was proposed by Mr. Bain as far back as 1843, and his method of accomplishing it was as follows (see Fig. 9). Behind the minute hand at 12 o'clock is placed a V, and in the minute hand is a pin. Every hour a current from the standard clock raises the V. Should the hand be fast or slow it is immediately forced to the hour, for the pin is bound to find its position at the bottom of the V. A plan similar in operation has recently been patented by Messrs. Barraud and Lund. It is fully described in NATURE, vol. xix. p. 55.

Another method of correcting clocks was invented by M. Collin, Chevalier of the Legion of Honour, and has been largely made use of by him. Fig. 10 shows his standard clock, and Fig. 11 the clock to be corrected; the latter is regulated to gain a second or two per hour. A few minutes before each hour the lower of the two detents in Fig. 10 is lifted against the upper, and a current passes. As regards the clock, Fig. 11, the current avoids

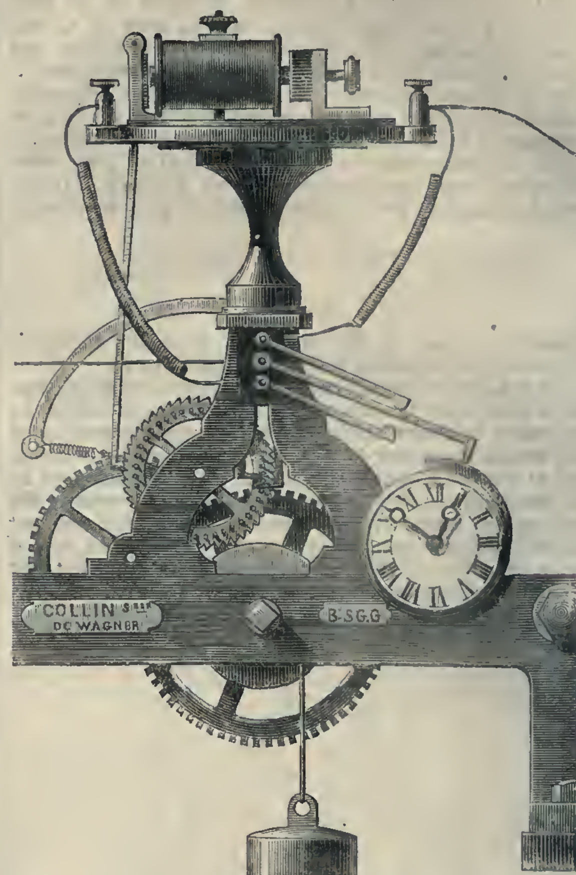


Fig. 11

for the present the coil mounted on the top of it. When

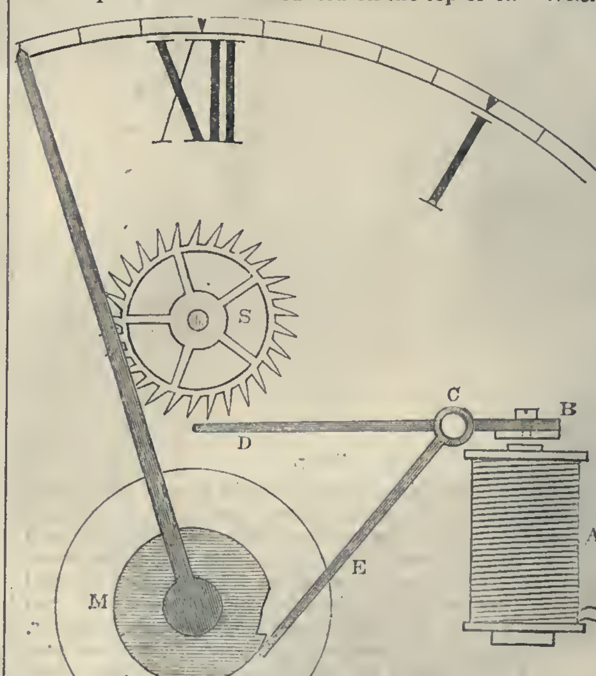


Fig. 12.

the clock, Fig. 11, reaches the hour, it allows the long

detent shown in the drawing to fall; this closes the circuit, and a hook attracted by the coil, catches a tooth cut in the escape-wheel, and holds it till the standard clock reaches the hour. At the hour the standard clock, Fig. 10, allows the lower detent to fall, and so breaks the circuit. Consequently the clock, Fig. 11, starts off side by side with the standard.

Mr. Ritchie, to whom we have referred before, has also devised a plan for correcting clocks by hourly currents. His clock, to be corrected in like manner, gains some second or two per hour. Fifteen seconds before each hour the lever D B (see Fig. 12) is attracted by the electro-magnet A, and a pin in the arm D would thereupon enter and catch a tooth of the escape-wheel, did the disc M allow the other arm of the lever E to move. When the hand reaches the hour, E falls, then D catches S and holds it till the cessation of the current at the sixtieth second of the governing clock.

Generally the use of a long telegraphic wire can only be commanded for a few minutes daily. Fig. 13 shows a very suitable arrangement to be adopted when this is the case. By means of the 24-hour disc the line wire is held in communication with the telegraph office until a

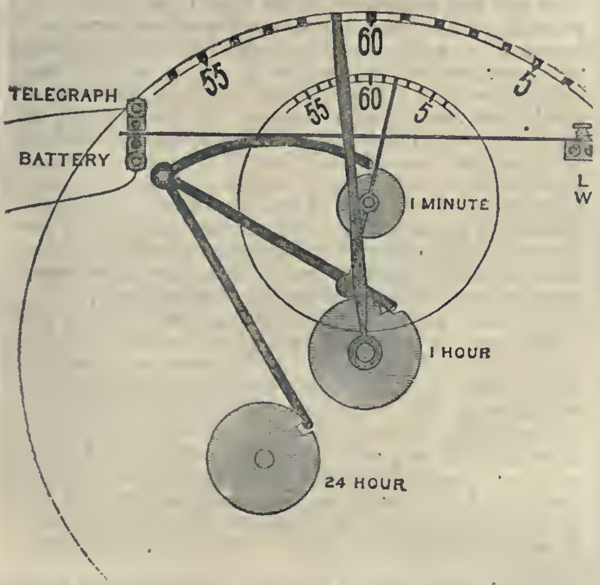


FIG. 13.

few minutes before the clock current is going to be despatched. The notch in the 24-hour disc will at last allow the system of levers to fall, but then the 1-hour disc supports them until about one minute before the clock current is coming; so that, till then, the line is being used for messages. The line wire has not been allowed to fall into circuit with the battery wire; this is still prevented by the 1-minute disc. At the sixtieth second precisely the 1-minute disc allows the line wire to join the battery wire, and out goes the clock current. Some seconds afterwards the 1-hour disc lifts the line wire back into communication with the telegraph office, where it stays for another twenty-four hours.

The Great Westminster Clock reports its own time to Greenwich by the following arrangement:—Some minutes before a signal is due, a lever is lifted by a slow wheel into such a position that a pin in the next wheel at its coming rotation will catch it. The second wheel lifts it so much further that a pin in the escape wheel reaches it, presses two slight springs together, and sends off the signal.

A method of driving an electric dial was contrived by the late E. J. Dent. A powerful magnet was lifted through a coil of insulated wire by a strong tower clock movement. Every half minute the magnet was dropped a current was generated in the coil, which proceeded to the dial and moved the hands. A plan on the same principle has lately been used for driving a number of small dials. A pendulum having a hollow coil of insulated wire for a bob, is by a heavy weight kept oscillating over a system of magnets. Currents are generated in the coil which proceed to the dials and work them.

Only the principal inventions in electrical clocks and clock-work have been indicated in this article. Since the year 1843 upwards of thirty patents have been applied for for improvements in such clocks and clockwork. It will be seen from this the subject, though not a wide one, is extensive.

Mr. Ritchie kindly lent diagrams 5, 6, 9, 12, and 13 to illustrate his plans, and M. Collin 10 and 11. Figs. 1 and 3 have been arranged to exhibit their working with clearness.

HENRY DENT GARDNER

TAUNTON COLLEGE SCHOOL

WE are sorry to chronicle the extinction of a school once watched with interest by all supporters of scientific education. The company which formed it is insolvent; the school buildings with the fine library and all the collections and apparatus which the late head-master amassed will be sold for the benefit of the creditors; the shareholders will lose their money; and the town will fall back for its higher education on the old, dilapidated, unhealthy grammar school.

The directors of the company, who constituted the council of the school, have performed no ordinary feat. Four years ago the school was nearly full, its annual profits considerable, its distinctions, and consequent reputation, unprecedented in so young an institution; public lectures in literature and science attracted to its hall large classes from the town and neighbourhood; and its systematic teaching of science to all its pupils was studied and imitated by many other schools. The council exhibited sudden activity; they starved the teaching-staff, interfered with the discipline and management, thwarted, harassed, humiliated the head-master. Warnings from parents and old pupils fell upon them unheeded. The last term of 1877 saw two open scholarships at Oxford, two places in Cooper's Hill, and a host of minor honours gained by the boys; but it saw also the head-master bullied into resignation, and all but a handful of the pupils withdrawn by their indignant friends. The fate of the school was clear to all except the council; it has lingered on only to add to the liabilities of the share-holders, who have now met to learn from their directors the history of a great scheme blighted, of insolvency far beyond the value of the mortgaged property, of their ancient school relapsed into the feeble, obsolete, provincial position from which Mr. Tuckwell rescued it.

ON SUPERSATURATION

A SOLUTION is a case of adhesion overcoming cohesion; and when these two forces are in equilibrium the solution is said to be *saturated*.

In general the adhesive force is diminished by lowering the temperature, and a portion of the solid, a salt, for example, is thrown down; but it is increased by raising the temperature, so that the liquid can take up an additional portion of the solid.

In the case of a large number of salts, but for the most part those that are hydrated, a solution saturated at a given high temperature can be reduced to a lower one without depositing any salt, in which case the solution is said to be *supersaturated*, because it contains more salt than it can take up at the reduced temperature.

For example, 100 parts of water at 194° F. will

take up 209 parts of potash alum, but at 32° only 4 parts. A boiling solution of alum containing 209 parts of the salt in 100 of water may be reduced, in a covered vessel, to the freezing-point of water without depositing any salt; in such case the water at 32° holds 52¼ times more salt in solution than it can take up at that reduced temperature.

The phenomena of supersaturation are, perhaps, best exhibited by means of Glauber's salt, or sodic sulphate, of which there are three forms, namely, the normal salt, containing ten atoms or proportionals of water of crystallisation, the seven-atom salt and the anhydrous. If two or three ounces of the normal salt in one ounce of water be gradually heated in a flask to 93° F., its point of maximum solubility, it will be completely dissolved, but if the heat be applied too suddenly or too fiercely, the anhydrous salt is thrown down, and occasions violent bumpings of the vessel. If the solution be properly conducted, it can be raised to the boiling-point, and so be left to cool (the mouth of the flask being covered) to the temperature of the air, without depositing any salt. It is now supersaturated. If, however, the solution be cooled to about 40° F. and under, the modified seven-watered salt is thrown down, the mother-liquor remaining supersaturated. If the flask be left uncovered, or the solution be touched with a proper nucleus, radiating lines, or rather plates of crystals of the normal salt, diverge from a point on the surface, and proceeding rapidly downwards, seem to interpenetrate the seven-watered salt, destroying its transparency, changing its molecular structure, whereby it assumes the appearance of boiled white of egg, and imparting to it three additional equivalents of water. The solution has now become solid, and the temperature considerably raised in consequence of change of state.

The condition of supersaturation was first noticed by Dr. Black towards the end of the last century, and from that time to the present many scientific men, both of this country and of the Continent of Europe, have studied the subject, often with contradictory results. The phenomena connected with the nuclear action of bodies in producing the sudden crystallisation of these solutions seem to behave differently in the hands of different inquirers; so that the facts affirmed by one writer are denied by another; and the theory which seems to have been disproved by one is again brought forward by another. Thus, to quote only a few of these contradictory statements, Ziz found that air and solids act best as nuclei when dry; if wet, or boiled with the solution or thrown into it while hot and allowed to cool with it, they are inactive: Löwel denies that air has any nuclear action, but that solids exposed to the air become active by a sort of catalytic force, and that alcohol is active: Liversidge and others deny that alcohol is active: Selmi states that dry air is nuclear, and acts by getting rid of water at the surface and producing crystals which continue the action: Gay-Lussac had before expressed a similar opinion: Lieben found that soot, platinum black, and pounded glass are nuclei: Schröder remarks that it is always a matter of chance whether such or such a substance produces crystallisation; Gernez, Viollette, Schiff, and Liversidge are satisfied that there is only one nucleus, and that is a salt of the same kind as the one in solution or isomeric therewith; and that when liquid and solid bodies apparently act as nuclei they are really contaminated with minute particles of the salt which is supposed to be always floating in the air: Jeannel opposes this theory, and Pellogio "gives proofs that the phenomena of supersaturation are not so simple as the French physicists would imply;" he finds that porous bodies act as nuclei: Viollette and Liversidge, on the contrary, find that porous bodies and bodies greedy of water and capable of being hydrated, such as absolute alcohol, fused sulphate of copper, quicklime, &c., are quite inactive.

In the midst of all this conflict of testimony, my own results were not likely to escape censure. Indeed, they have been attacked with a degree of acrimony which seems to be very much out of place in the calm inquiry after scientific truth, and in the presence of so many contradictory results produced by eminent conscientious observers. I was not able for a long time to account for the negative results which were opposed to my positive ones, and I threw the subject aside. At length, however, I was led to suspect that nuclei are powerfully affected by varying atmospheric conditions, whereby they sometimes determine the solidification of these solutions, and at other times not. Accordingly I undertook a series of daily observations which extended over some months, working with a standard solution of sodic sulphate and an essential oil, and the result was that when the wind at Highgate was northerly or easterly, the oil was nuclear, but with a westerly or southerly wind it was inactive. It was obvious, then, that there was some force present in the air which rendered the oil active, which being absent, the same oil remained passive. I succeeded in identifying this force with ozone, and judging that wherever ozone was present, irrespective of the direction of the wind, the oil would become nuclear, I visited several places, notably one by the sea-side, and was confirmed in the view I had taken. For example, at Eastbourne a westerly wind produced in the course of ten minutes a deep orange brown stain on ozone test-paper, and oils exposed to its action became singularly active after a few minutes' exposure. Freshly distilled oil of lemons, oil of cajuput, oil of turpentine, &c., were inactive in the house on supersaturated solutions of sodic sulphate and of alum, but by the sea-side far away from the town, with the wind blowing in the direction of the town, or at the end of the pier, 1,012 feet from the shore, with the wind blowing from the sea, the oils were allowed to fall in drops from a dropping tube into a small clean beaker for about three minutes, when they became powerfully active in rendering the solutions solid.

In my first papers on this subject (*Phil. Trans.*, 1868-1871) a nucleus is defined as a body that has a stronger attraction for the salt, or for the water of a solution, than subsists between the salt and the liquid. Examples are given in which oils, fixed and volatile, alcohol, ether, &c., spreading on the surface of the solution, produce a separation of salt, and the rapid solidification of the solution; whereas, if such liquids, instead of spreading, assume a lenticular form, they are inactive, and may, by shaking the flask, be dispersed through the solution in numerous globules without any immediate nuclear action.

Several circumstances favour the action of these liquids as nuclei: (1) Chemically clean flasks and solutions, so as to maintain (2) the surface tension of the solutions as high as possible, in order to spread a drop of oil, &c., into a film; (3) bright and clear weather, with strong evaporative force.

A newly distilled essential oil is inactive, on account of its strong cohesive force, and when a drop of it is dispersed in globules through the solution, each globule retains its surface-tension, whereby it is prevented from coming into contact with, and separating a molecule of the salt held in solution. The action of ozone is an oxidising one, diminishing the cohesive force among the particles of the oil, just as rust weakens the cohesive force of a bar of iron.

The effect which ozone produces quickly on a newly distilled volatile oil, is produced slowly on the same oil by long keeping. Its cohesive force is so far weakened, that a drop of it on the surface of the solution no longer tends to assume the lenticular form, or to disperse in globules through the solution. Then, as oil can adhere much more strongly to salt than to water, and the supersaturated solution being a highly charged system capable of yielding to a force that is exerted in the right direction, such an oil adheres to and separates a molecule of the salt, and the

action once begun is rapidly propagated, until the whole solution is solid.

In like manner newly refined fixed oils may have their cohesive force degraded by various chemical means, as by being treated with an alkali, or with nitric acid, &c., in which condition they are commonly nuclear. Solid and semi-solid fats, such as suet, dripping, lard, butter, fat of meat, &c., act powerfully as nuclei. The freshly cut surface acts most effectually, and, in some cases, a fat cut in one direction may not act for hours, while if cut in another direction it may act immediately. A glass rod smeared with lard, &c., may act better than a small lump of the material.

Several observers, who deny that the oils, &c., have any nuclear action, so contrived their experiments as to expose the oils, &c., to the action of heat, while carefully excluding the outer air. The effect of such manipulation is to increase the cohesive force of the bodies in question; and as they fail to act under such conditions, it was denied that they ever acted at all under other conditions, except when contaminated with particles of the salt more or less ultra-microscopic.

So also in testing the nuclear action of porous and dehydrating bodies, heat is employed, and this destroys the very activity which is about to be tested. Freshly ignited quicklime, for example, is inclosed in thin glass bulbs, sealed, heated to redness, and dropped into the supersaturated solutions. When cold, the bulb is broken, and the contents set free, but in no case with any result.

I have found that porous bodies, such as pumice, plaster of Paris, &c., may be rendered inactive by being treated for about ten minutes in a test tube plunged into boiling water. But when such bodies are thrown into the solutions without any separation of salt, it is not that exposure to heat has rendered them less active as nuclei; they have become in fact more active than before, for they now absorb the solution as a whole instead of its water only; whereas, if after being heated, these porous bodies are exposed to the outer air during ten minutes, they take in a little moisture which tames down their absorptive power, so that when placed in the solution they act more slowly, absorbing water and thereby producing a separation of salt and the solidification of the solution. Absolute alcohol acts in a similar manner. Crumb of bread is a very good porous nucleus.

As to the condition of sodic sulphate in solution there are many reasons for supposing that it is the anhydrous salt; that is, the normal salt gives up the whole of its water of crystallisation to the solution. When by a reduction of temperature a portion of the salt is separated, it combines with seven atoms of water, and this is not nuclear. So also when nuclei fail to effect the solidification of the solution, they cannot be said to be inactive, since they act within certain limits of temperature by throwing down the modified salt. But when nuclei are active in determining solidification they form a kind of *point d'appui*, which enables the disengaged molecule to combine with ten atoms of water, and this is nuclear to the rest of the solution and determines its solidification.

The state of supersaturation is dependent to a considerable extent on the adhesion of the solution to the walls of the vessel. If a portion of this be detached by rubbing or scratching the side below the surface with a strong clean wire the whole system breaks down and the solution immediately becomes solid. If the vessel, such as a test tube, be lined with resin, amber, or some substance to which the solution has a weaker adhesion, it generally becomes solid in cooling. Or if a highly supersaturated solution be poured boiling hot into a shallow vessel, in which the surface of adhesion and the free surface are nearly equal, the solution relieves itself by throwing down a considerable quantity of the modified salt, at temperatures above that at which it is usually formed in narrower and deeper vessels.

I have thus very briefly stated the results of my researches on this difficult subject, and submit them to the candid judgment of fellow-labourers in the same field.

C. TOMLINSON

OUR ASTRONOMICAL COLUMN

VENUS IN THE PLEIADES.—A thousand years ago and later the geocentric track of the planet Venus was occasionally such as to cause it to traverse the Pleiades, a phenomenon which, in these telescopic days, would be one of no small interest to the observer; prior to the invention of the telescope its effect would be merely to obliterate in a great measure, for the time being, the stars forming this group, particularly when the planet happened to be upon them near an epoch of greatest brilliancy. Amongst the observations collected from the Chinese annals and forwarded to Europe in the middle of the last century by the French Jesuit, Gaubil, we find one made under the dynasty *Tang*, in the fifth year of the period *Hwuy-Chang*, on the day *Jin-Woo*, of the second moon —corresponding in the Julian Calender to A.D. 845, March 16—when "Venus eclipsed the Pleiades;" the observation appears to have been made at *Si-gan-fou*, where the *Tang* dynasty had their court, and where the earliest occultation of a star or planet by the moon, that of Mars B.C. 69, February 14, was also observed. If we found an examination of this "eclipse" of the Pleiades by Venus, upon Leverrier's data, using them with a sufficient degree of approximation for the purpose in view, it appears that at dusk at *Si-gan-fou*, on March 16, 845, Venus was situate near the star *Electra*, not far from the parallel of the principal star of the group *Alcyone*, but three-quarters of a degree to the west of it, and that about the same time on the evening of March 17, after having passed close to *Maia*, the planet would be in the same right ascension as *Alcyone*, about twenty-four minutes to the north. Although the so-called eclipse of the Pleiades might commence therefore on March 16 as the Chinese record, Venus would be more centrally upon the group on March 17, according to our modern tables. Her apparent diameter was then thirty seconds, and she would shine with more than average brilliancy. Another eclipse of the Pleiades is mentioned under the later *Sung* dynasty, on March 10, A.D. 1002.

VARRO'S STORY OF THE ANOMALOUS TRACK AND FIGURE OF VENUS.—In a *résumé* of the recent progress of astronomy contributed to an American work by Prof. Holden, of Washington, we note a reference to a communication made by M. Boutigny to the Academy of Sciences at Paris in December, 1877, calling attention to a passage in Varro, which describes the planet Venus, as having about the year B.C. 1831 (not B.C. 31, as misprinted in Prof. Holden's Report) "changed its diameter, colour, figure, and course." M. Boutigny had probably overlooked the circumstance that this story of Varro's had been brought into notice long before, in a French work of astronomical authority, the "Cometographie" of Pingré, who, believing that the fable was originated by some celestial phenomenon, considered it was most probably due to the appearance of a bright comet. Pingré thus gives the fragment, preserved by St. Augustin:—"There was seen, says Varro, a surprising prodigy in the heavens, with regard to the brilliant star Venus, which Plautus and Homer call, each in his own language—the evening star. Castor affirms that this fine star changed its colour, size, figure, and track, which had never occurred before, and which has not occurred since. Adrastus, of Cyzicus, and Dion the Neapolitan, refer this great prodigy to the reign of Ogyges." Pingré's explanation will be found in "Cometographie," t. i. p. 247; the epoch he assigns for the phenomenon is "vers 1770."

The story has no astronomical importance, and is only noticed here from its revival so recently, as mentioned above.

NOTES

THE death is announced, at a venerable age, of Sir Thomas Maclear, F.R.S., formerly Astronomer-Royal at the Cape. We hope to be able to give a brief notice of his life and work in our next number.

AT a recent meeting of the Local Committee of the British Association Mr. Harold Thomas and Mr. W. K. Marples, the secretaries of the special committee for arranging the excursions, gave explanations concerning the proposed visits to twenty different places of interest in the district, including Chatsworth, Wentworth, Castleton, Cresswell Crags, Roche Abbey, Sandbeck, Welbeck, Thoresby, Matlock, Arbelow, Stanton-in-the-Peak, Conisborough, Haddon, Hardwick Hall, Bolsover, Wharncliffe, Stainborough, Beauchieff Abbey and Beauchieff Hall, Wingfield Manor, Bradfield, &c. At Arbelow, Sir John Lubbock is to give a lecture on the Druidical remains, which are a source of so much interest to antiquarians visiting that quarter. It was stated that Prof. E. Ray Lankester, F.R.S., had been appointed by the Association to take the place of the Rev. Mr. Dallinger, who is ill, as one of the lecturers for the meetings, and will deliver his lecture at the Albert Hall at 8.30 on Monday evening, August 25, his subject being "Degeneration." Among those who have already signified their intention of being present are Major Serpa Pinto, M. Daubrée, President of the Academy of Sciences, Paris; Prof. Zirkel, Professor of Geology, &c., Leipzig. There have also accepted the invitation to the Sheffield meeting the following, amongst others:—L'Abbé Renard, Keeper of Minerals of Royal Museum, Brussels; Prof. H. A. Newton, Yale College, N.H.; Dr. Wüllner and Madame Wüllner; Dr. Janssen, M. Veth, Leyden, Holland (a traveller in Sumatra); Lieut. Wyse, of the French Navy, and Madame Wyse.

IF any of our readers are within hail of Baden-Baden about the middle of September, they should not fail to pay it a visit some time between the 18th and 24th. The German "Naturforscher," we are sure, will give them a genuine welcome, and they will get a lesson worth learning of how an association of many hundreds from the cream of German science can as a united body combine the severest work with play so hearty as almost to approach "high jinks." In sections and out of sections the German *savants* meet as a body, work as a body, and enjoy themselves as a body. On the morning of September 18, for example, you can listen to Prof. Hermann, of Zurich, lecturing on the acquisitions of physiology in the last forty years, or to Prof. Hirschfeld, of Dresden, on mimic movements of the countenance from a Darwinian point of view, and in the afternoon listen to the military band at the foot of the old castle, finishing off at the theatre in the evening. On Saturday Dr. Nachtigal is to lecture, while the evening is to be devoted to dancing. Sunday is the great day for excursions, while Monday and Tuesday are devoted to sectional work, with fireworks, theatre, and concerts in the evenings. The session finishes on September 24, with, among other things, a lecture on food adulteration, by Dr. Skalweit, of Hanover.

THE biennial meeting of the International Astronomische Gesellschaft will take place at Berlin on September 5-8 next. Prof. Förster, director of the Royal Observatory, will, on application, give more detailed information.

IMMEDIATELY after the meeting of the German Association at Baden-Baden on September 14-24, the German Geological Society will hold its general meeting at the same place, viz., on September 25-28.

THE forty-seventh annual meeting of the British Medical Association was opened at Cork on Tuesday, Prof. O'Connor, of Queen's College, Cork, being president.

THE Cameron Prize, recently founded in Edinburgh University by the late Dr. A. R. Cameron, of New South Wales, "for the most important addition to Practical Therapeutics in the past year," has been awarded to Dr. Paul Bert, Professor in the Faculty of Sciences, Paris, for his researches extending over a series of years and summarised in his work entitled "La Pression Barométrique; Recherches de Physiologie Expérimentale" (Paris, 1878).

MR. TEGETMEIER, we understand, lends his aid as regards press-work of the reprints to be issued by the newly established Willughby Society, which could not have a more efficient director, as the fidelity of his reproduction of Moore's *Columbarium* and Boddaert's *Table* is enough to prove.

ON the morning of Sunday, August 3, a little before two o'clock A.M., the Royal Gardens at Kew were devastated by a hailstorm, which in the space of about ten minutes inflicted more damage than the Gardens have sustained since their existence as a national institution. After a rapid survey of the houses the following day, it was found that the number of broken squares of glass could not be estimated at less than 16,000. In the great temperate house alone 3,000 squares were shattered. The storm, which was accompanied by violent thunder and lightning, drove over the gardens from the north-east, and expended its greatest fury in the direction of Richmond. The temperate house suffered the full effects, while the palm house being apparently a little to the west of its course, escaped with the destruction of 700 panes. The hailstones were found to average one and a half inches in diameter, and to weigh three-quarters of an ounce. They came down with sufficient force to bury themselves in the bare earth of the flower borders, and even penetrate the turf to the depth of an inch. In some cases perfectly circular holes were cut out of the glass panes, while the hailstones went through the succulent leaves of the Echeverias planted out in the beds with as clean an outline as if it had been made with a punch. On account of the confusion produced by the damage and the danger from falling splinters of glass, it has been necessary to close all the houses to the public. The present low night-temperature, and the probability of heavy showers, are grounds for the gravest anxiety as to the preservation of the collections which, however speedy the repairs of the houses, cannot fail to suffer considerable injury. The damage is estimated at not less than 2,000*l*., as many of the houses being a good deal dilapidated, cannot be put in order without entire re-glazing, re-painting, and partial renewal, and application will have to be made to Parliament for a supplementary vote to defray the cost.

WHILE the Abbé Moigno will continue to edit *Les Mondes*, the proprietorship has been converted, he informs us, in the last number, into a sort of joint-stock company, thereby relieving him of all responsibility, and leaving him all his energy to carry on his scientifico-religious propaganda.

WE learn that the late member of the St. Petersburg Academy, Prof. Brandt, has left a mass of MSS. of great value. Among this are two important works which he has left unfinished; one on the contributions made by the St. Petersburg Academy for the advance of zoology, and a synopsis of the fauna of Russia. The MSS. will be published by the numerous friends the late Professor has left in the Academy, and by his son.

THE Royal Academy of Sciences at Munich has elected the following gentle men as Corresponding Members of its physico-mathematical class:—Prof. Edm. Hébert (Paris), Prof. J. F. Pfaff (Erlangen), Prof. Theod. von Oppolzer (Vienna), Prof.

Ant. de Bary (Strassburg), Dr. N. Pringsheim (Berlin), and Prof. O. E. Meyer (Breslau). Dr. Felix Klein of Munich has been elected as Extraordinary Member.

THE first congress of all the German societies for the protection of animals will be held at Gotha on August 17–19 next.

THE Imperial "Leopoldino-Carolinische" German Academy of Naturalists has presented the well-known Göttingen professor of physics, Dr. Wilh. Ed. Weber, formerly one of Gauss's collaborateurs, with the Cothenius medal, in recognition of his valuable services for the furtherance and progress of experimental physics.

THE following is the prize theme given by the physico-mathematical class of the Royal Academy of Sciences of Berlin:—According to Faraday's theory of electrodynamics, as worked out mathematically by Prof. Clerk Maxwell, the generation and disappearance of dielectric polarisation in isolating media as well as in celestial space, are phenomena which possess the electrodynamical effect of electric currents, and which can be called forth like the latter by electrodynamical induction forces. The currents in question would, according to the theory, be equal in intensity to that one which charges the boundary surfaces of the conductors electrically. The Academy now demands that decisive experimental proofs be given for or against the existence of electrodynamical effects of nascent or disappearing di-electric polarisation, of the intensity supposed by Prof. Maxwell, or for or against the generating of di-electric polarisation in isolating media by means of electromotoric forces induced magnetically or electrodynamically. The term for sending in solutions of the theme ends on March 1, 1882.

ON the 1st inst. a century had passed since the birth of the celebrated naturalist and philosopher, Lorenz Oken (properly Ockenfuss). Oken was born on August 1, 1779, at Bohlsbach, in Swabia, and died on August 11, 1851, at Zurich. He had held for many years the post of professor of natural history at Jena, Munich, and Zurich. His principal works are the well-known "Lehrbuch der Naturgeschichte" and "Allgemeine Naturgeschichte für alle Stände."

RUSSIAN newspapers announce, as we stated last week, that a very rich archæological find has been made by M. Kibalchich, in Southern Russia, on the banks of the Trubesh River, in the Government of Poltava. In a locality covered with numerous small mounds, a sheet of earth with pieces of coal, bones, broken pieces of earthenware, as well as stone and bronze implements, were discovered under the recent sands. The number of stone arrows and knives discovered is no less than 372; besides, M. Kibalchich has found two larger stone implements which were used for breaking great bones, several clay and glass ornaments, earthenware with ornaments, and five bronze arrows. This find is the first in Southern Russia, whilst, as is known, the remains of the stone and bronze periods are very numerous in Northern and Eastern Russia.

A CAPTIVE balloon has been established in Berlin, and was inaugurated on July 27. But the wind having blown with some velocity, the balloon was opened, and the occupants of the car were precipitated to the ground. A tree having diminished the shock, the travellers escaped almost unhurt. The Berlin balloon was about $\frac{1}{11}$ the size of the Paris balloon, inflated with coal gas, and the cover ordinary silk. The *Norddeutsche Zeitung* asks for police inspection before new ascents be made. The intended height was only 500 feet, and the number of passengers two or three.

ON August 30 M. Gaston Tissandier made an ascent from La Villette Gas Works with his wife and his brother. The travellers started at 5h. and landed at 7h. 50 at Dawmartin. The observations were highly interesting. When the *National* left ground, the wind was blowing south-westerly, but at about 7h. the direction changed abruptly, and an instantaneous change took place in the direction of the balloon. It was caused by the *brise de mer* setting in after a hot day. The sky was covered with cumulus, intermixed with a few cirrus of small dimensions. When at an altitude of 600 metres, M. Tissandier passed through a cloud which was very cold indeed, as proved by the sensation which the travellers experienced, but the duration of the passage was so short that it was not possible to observe the temperature at the thermometer. When at a higher altitude M. Tissandier observed the refraction of the rays of the sun on icy particles, and at the same moment on the western sky splendid rainbows. At the same time a very large halo had been observed at Paris by the *Temps* meteorological editor, and noted by him.

DR. DUNANT publishes in the *Journal de Genève* a note on the low temperature of this summer. While the mean temperature for the years 1873 to 1878 was 18°·9 Celsius in June, and 21°·0 during the first half of July, in 1879 it was only 18°·8 and 16°·7.

THE Ramon Société of Toulouse is organising an ascent on the Pic du Midi, to inspect General Nansouty's Observatory. The peak is covered with unseasonable snow, but it will not prevent the ascent from taking place, it is expected, without any great difficulty.

A SHOCK of earthquake was felt on July 20 at 3·30 A.M. at Vulpera, in the Engadine (Switzerland). It was accompanied by a rather strong rumbling.

AN earthquake consisting of three moderately violent shocks is reported from Cairo. The phenomenon was observed in the night of July 11-12. In the quarter of Bab-en-Nasr, which is at some distance from the modern portion of the city, some isolated walls fell in, and an old and somewhat dilapidated minaret has suffered so severely that it must be taken down. During the last decades earthquakes have been extremely rare at Cairo and indeed in Egypt generally, and since the great earthquake of 1857, which caused so much damage amongst the shaky old buildings, in which the Caliph-city abounds, and through which several lives were lost, no earthquake of importance has occurred. The phenomenon of July 11-12 is said to have been noticed also at Gizeh, near the great pyramids.

THE Manila papers state that a terrible thunderstorm passed over that city on May 31. It was preceded by an almost suffocating warm atmosphere and rain, and lasted about an hour. The lightning struck the Binondo Tower, damaging the crystal shade of the clock, but not injuring the mechanism, though the stone work forming the arch was much damaged. Out of several persons in the tower at the time, four appear to have been killed. Several other places in the city were more or less injured.

WE have received from Mr. Henry Chichester Hart, B.A., a copy of his collected papers "On the Flora of North-West Donegal," which have been appearing in the *Journal of Botany*. These floras of particular districts are valuable contributions to a perfect knowledge of the British flora in general, for it is evident that a more thorough exploration of a given range can be better effected by confining the observation to a small circuit than by extending them almost indefinitely. Many points of interest in the localities of species are more clearly indicated by these contributions than we expect to find in a work which treats of the flora of the entire country. As an illustration of the utility of these papers we may refer to the fact that *Ophioglossum lusitanicum*, L., was found by Mr. Hart in August last amongst short grass near the margin of a cliff on the northern side of

Horn Head; the fronds were fertile at the time notwithstanding that the plant has been usually quoted as flowering in January. Mr. Hart further points out that the claims of this fern to a place in the British flora have hitherto rested upon its known habitat in Guernsey.

In the June number of *The California Horticulturist*, amongst other articles of horticultural and local interest, is one on the Sierra Forests, pointing out the great risk there is of these magnificent forests becoming denuded as they "are now and for many years have been, at the mercy of private greed and public theft." The writer says it is true no changes are yet manifest, there are miles of forest left, and ravines wherein no chopper's axe has yet resounded. It is not the axe that is feared but the sheep and cattle owned by private individuals that have for years been pastured on the Government lands of the Sierras. The common practice, it is said, has been for a man having perhaps five or ten thousand head of sheep to purchase one single quarter section from the Government to build his house on, and perhaps to hold the best springs of water. From that central point his flocks and herds roam for miles, under the spicy pines and cedars, trampling the soft rich ground until it is like iron, destroying every seed, killing all the young trees, and causing the State a yearly loss in the value of her forests, which is far more than the worth of the whole band of sheep. The article concludes with a reference to the matter having occupied the attention of some of "our best thinkers." "Prof. Sargent, of Harvard," we are told, "points out in the *Nation* the disastrous effects of such a policy; Prof. Hooker, of Kew Gardens, follows in the same line of thought; and John Muir mourns over the desiccated forest-shrines, and the rarer flowers and ferns, now rapidly passing out of existence."

Messrs. Longmans and Co. have just issued a little book on "Town and Window Gardening," being the substance of a course of lectures "given out of school hours to pupil teachers and children attending the Leeds Board Schools." These lectures were given by Mrs. C. M. Buckton, a member of the Leeds School Board, and author of two recently published books called respectively "Health in the House," and "Food and Home Cookery." These endeavours of Mrs. Buckton to raise the moral and intellectual welfare of the working classes are highly praiseworthy, and though the book before us may not claim a position amongst standard scientific works, yet there is much that is good scattered through it which cannot fail to raise the tastes of many a child fortunate enough to come under the influence of teachers like the authoress who have a real admiration for nature in all its branches and a heartfelt desire to impart as much knowledge as possible to the children of our crowded alleys.

The Tasmanian gold-fields are reported to be very successful, and some rich finds have occurred on the Pieman River. The locality is about seventy miles across country from the tin deposits at Mount Bischoff. Numbers of people are flocking to the diggings from all quarters.

The additions to the Zoological Society's Gardens during the past week include a Weeper Capuchin (*Cebus capucinus*) from Guiana, presented by Capt. Bond; a Brown Bear (*Ursus arctos*) from Russia, presented by Mr. J. R. Boyce; a Tawny Eagle (*Aquila nævioïdes*) from Southern Spain, presented by the Marquis de la Granja; a Bateleur Eagle (*Helotarsus ecaudatus*) from the Isle de Bas, Sierra Leone, presented by Mr. Alex. Sinclair; two common Crossbills (*Loxia curvirostris*) European, presented by Mr. H. A. Macpherson; a Common Cuckoo (*Cuculus canorus*), British, presented by Miss C. Bealey; a Central American Agouti (*Dasyprocta isthmica*) from Central America; two White-faced Tree Ducks (*Dendrocygna viduata*), a Red-billed Tree Duck (*Dendrocygna autumnalis*) from Rio Magdalena, purchased.

SOUTH CAROLINA FOSSILS

In a paper on "Vertebrate Remains, chiefly from the Phosphate Beds of South Carolina," published in the *Journal* of the Academy of Natural Sciences of Philadelphia (vol. viii. part iii.), Prof. Joseph Leidy prefaces his careful description of the many separate remains by a few general remarks on the subject, some extracts from which may interest our readers. The fossils are mainly from the so-called Ashley phosphate beds of South Carolina, which "are composed of sands and clays, intermingled with irregular porous masses of more coherent rock rich in calcium phosphate, together with many organic remains. These beds, the economical importance of which was fully made known in 1868 by Prof. Francis S. Holmes and Dr. N. A. Pratt, of Charleston, occupy a large extent of country in the southern part of South Carolina, on the Wando, Cooper, Ashley, Stono, Edisto, Coosaw, Asheepo, and other rivers. According to Prof. Holmes, from 'fifteen to eighteen inches may be considered the average thickness of the stratum of the phosphate rocks.'[1]

"The exact stratigraphical relations of the beds and the relative age of these and contiguous strata have not been as thoroughly investigated as is desirable, and in many cases the particular horizon to which belong the fossils that have been discovered has not been positively determined. According to Prof. Holmes, the phosphate beds are of the post-pliocene period and overlie strata pertaining to the pliocene period and these are again succeeded by a soft marl rock of eocene age, the whole being covered by modern alluvium.

"The phosphatic rocks or nodular masses of the phosphate beds, said to contain as high as sixty, or even more, per centum of calcium phosphate, are of irregular shape, and range in size from small pieces up to masses of a thousand pounds or more.[2] They contain many casks of molluscous shells, which appear to be of the same forms as those which occur in the eocene or miocene marl rock beneath. They also frequently contain imbedded bones and teeth, mainly those of marine fishes and cetaceans.

"The phosphatic nodules are supposed to have been derived from the tertiary marl bed beneath, and are considered to be detached and altered fragments from the surface of that bed. The irregular, eroded, and porous masses have the appearance of being detached and water-rolled fragments of the tertiary marl rock after it had been tunnelled by various boring molluscs. It is, indeed, not improbable, as has been suggested, that in the later part of the eocene or miocene period and subsequently the easily penetrated rock was bored and rendered spongy by the incessant labours of multitudes of *Gastrochæna*, *Petricola*, *Pholas*, &c. At the time or later, neighbouring and superficial islets, the resorts of myriads of sea-fowl, may have furnished the material which, when washed with the ocean and mingled together with the decomposing remains of marine animals, supplied the element for the conversion of the porous marl rock into the more valuable phosphatic compound.

"Besides the phosphatic nodules, the Ashley beds present a remarkable intermixture of the remains of marine and terrestrial animals, consisting of bones, teeth, coprolites, shells, &c., derived from the contiguous formations of various ages from the early tertiary to those of a comparatively recent period.

"Of remains of vertebrates, those of fishes and cetaceans prevail, especially the teeth of sharks and the vertebræ of whales. Less frequently there occur the vertebræ and teeth of large teleost fishes, the dental pavements of rays, fragments of turtle shells, vertebræ of crocodiles, ear-bones and teeth of cetaceans, bones of manatees, &c. With these likewise are found the remains of both extinct and still existing terrestrial mammals, especially teeth and bone fragments of elephant and mastodon, megatherium, horse, tapir, bison, and deer. More rarely there are found remains of hipparion, castoroides, hydrochærus, and of the smaller and more common genera of species.

"The fossils mainly consist of the harder parts of the skeleton and of teeth, usually more or less water-worn, indicating shallow seas and an active surf to which they were exposed. Many of them exhibit the drilling effects of boring molluscs, especially those which are supposed to have been derived from the tertiary marl rock, the operation of drilling apparently having been performed both before and during the time the fossils were embedded in the rock. Only enamel or the enamel-like dentinal

[1] "The Phosphate Rocks of South Carolina." By Francis S. Holmes, A.M., Charleston, 1870, p. 70.

[2] A nodular mass, on exhibition in the government building, from Charleston, S. C., weighs 1,150 pounds.

layer such as is found investing the crown of the teeth of sharks, appears to have been a protection against the drilling power of the borers.

"Fossils excavated from the phosphate beds are of a ferruginous brown colour, but often much lighter or white upon the surface. Those which are obtained from the rivers contiguous to the beds are usually more or less black, with the enamel of teeth iron-gray, and they frequently exhibit the basal attachment of small barnacles, and occasionally the valve of an oyster.

"From the fossils consisting mainly of the harder and denser, and therefore heavier parts of skeletons and teeth, they are generally assumed to be petrified, but usually the change has not been more than a moderate loss of the ostein basis and the infiltration of iron oxyd.

"From the extraordinary variety and profusion of the fossil remains of the Ashley phosphate beds it may be inferred that these were the former rich feeding grounds for multitudes of marine and amphibious animals. At an early period during the formation of the tertiary marl here congregated great sharks, rays, squalodons, &c. At a later period their successors varied their diet with the carcases of great land animals, as elephants, mastodons, &c., which floated down the broad and swollen rivers, as drowned herds of the bison are said to do in our day upon the Missouri River.

"Some of the remains of terrestrial animals, comparatively few in number, found as fossils in the Ashley phosphate beds, including even the softer or more spongey bones, exhibit no evidence of violent water action other than the signs of decay from the combined influence of moisture and air; neither do such fossils exhibit the marks of boring molluscs, nor the attachments of barnacles. Usually black and more or less friable, these fossils, such as the bones of mastodon, megatherium, deer, &c., are no doubt the remains of animals which became mired and sank into marshes of the Ashley phosphate beds after these had become elevated above the surface of the neighbouring sea. Of this nature, also, we may believe, are the remains of more recent animals, including also specimens of human bones, those of domestic animals, and stone implements, which are occasionally found in the Ashley phosphate beds."

SCIENTIFIC SERIALS

American Journal of Science and Arts, July.—Contributions to meteorology, by E. Loomis (eleventh paper).—Silurian formation in Central Virginia, by J. L. Campbell.—New form of spectrometer, and on the distribution of the intensity of light in the spectrum, by J. W. Draper.—Extinct volcanoes about Lake Mono, and their relation to the glacial drift, by J. Leconte. Mineral locality in Fairfield Co., Connecticut, by G. J. Brush and E. L. Dana (third paper).—Note on the progress of experiments for comparing a wave-length with a metre, by C. S. Peirce.—Recent additions to the marine fauna of the eastern coast of North America, by A. E. Verrill.—Position of the planets *Philomela* and *Adcona*, by C. H. F. Peters.—Method of preventing the too rapid combustion of the carbons in the electric lamp, by H. W. Wiley.—Bernardinite, a new mineral resin, by J. M. Stillman.—Notice of a new Jurassic mammal, by O. C. Marsh.—On the Hudson River age of the Taconic schists, by James D. Dana.—(Several of these papers are noticed by us elsewhere.)

Verhandlungen des naturhistorischen Vereins der preussischen Rheinlande und Westfalens (Bonn, vol. 35, parts i. and ii., 1878).—From these parts we note the following papers:—Section for Geography, Geology, Mineralogy, and Palæontology: Description of the Cotopaxi and its last eruption on June 26, 1877, by Th. Wolf (with plates).—On the eruptive rocks in the Saar and Moselle districts (with plates), by A. von Lasaulx.—Chemical examination of Westphalian and Rhenish rocks and minerals, by W. von der Marck.—New researches on the oldest Devonian formations of the Harz mountains, by C. Schlüter.—On some spiders and a myriapod from the brown coal of Rott (with plate), by Ph. Bertkau.—On some ferns from the coal flora, by Dr. C. J. Andrä.—On some new Cephalopoda from the North German chalk deposits, by C. Schlüter.—On the geology of Italy, by Herr vom Rath.—On O. Volger's new theory of wells and sources, by Dr. Mohr.—On the depths and configurations of the sea-bottoms, by Herr Fischer.—On the crystallisation of cyanite, by Herr vom Rath.—On the natural conditions of Elberfeld, Barmen, and neighbourhood, by Herr Cornelius.—On the development and importance of coal mining in the Rhineland and Westphalia.—On the geognostical conditions of the Oster Wood near Elberfeld, by Herr Buff.—On the mining operations in the Eifel from a historical point of view, by Herr Voss.—On some fossil bones from the Unkelstein, by Herr Schwarze.—On the perception of the earthquake of August 26, 1878, in the Rhenish mines, by Herr Fabricius.—On a fossil elephant's tusk from Hennef in the Sieg Valley, by Herr Buff.—On a löss-like formation in the diluvium of the Weser district, by R. Wagener.—Botanical Section: Further researches on the fertilisation of flowers by insects, by H. Müller.—On *Limodorum abortivum*, Sw., and *Epipogium gmelini*, Rich., by G. Becker.—On *Ophrys arachnites* and *O. apifera*, by the same.—On some rare specimens from the Rhenish flora, by the same.—On the persistence of flowers and fruits in their position with regard to the horizon, by Herr von Hanstein.—Anatomical and physiological researches on the nectaries of flowers, by Herr Behrens.—On the change of colour in leaves, by Herr Lindemuth.—Section for Anthropology, Zoology, and Anatomy: Herpetological drawings made by Rösel von Rosenhof (from his posthumous papers), discussed by F. Leydig.—On some parasitical hymenoptera, by A. Förster.—On the mollusk fauna of Westphalia, by P. Hesse.—On the clothes of man compared to the natural coats of animals, by Prof. Troschel.—On the whales occurring on the coasts of Japan, by Herr Mohnike.—On the spermatogenesis of mammals, by Prof. von la Valette St. George.—On the differences between *Atypus piceus*, Sulz., and *A. affinis*, Eichw., in the female sex, by Herr Bertkau.—On the bats of the Rhineland and Westphalia. On thirty-six species of fish caught in the Rhine near Linz, by Herr Melsheimer.—Section for Chemistry, Technology, Physics, and Astronomy: On the action of prussic acid, by Herr Wallach.—On normal weights made of rock crystal, by Herr Stein.—On a metallurgical work published in Japan in the seventeenth century, by Dr. Gurlt.—On celluloid, by Dr. Köster.—On the nature of the force of attraction, by Prof. Mohr.—On the decomposition of salicylate of soda by carbonic acid, by Herr Binz.—On Prof. Newcomb's researches on the motion of the moon, by Herr Schönfeld.—On the Rott tunnel near Barmen, by Herr Hövel.—On a universal hand-boring machine for hard rocks, by Herr Faber.

Journal of the Franklin Institute, July.—Power-transmitting mechanism; on the strength of the teeth of wheels, by Mr. Cooper.—Harmonic and basic lines and tendencies, by Dr. Chase.—Committee report on Olsen's testing machine.—Machines for measuring, by Mr. Richards.—The electric arc, its resistance and illuminating power, by Professors Thomson and Houston.—Effects of atmospheric changes on textile bands, by Mr. Woodbury.—Phosphorus in bituminous and anthracite coals, by Mr. Roney.

THE quarterly *Revue des Sciences naturelles* (2nd series, vol. i., No. 1).—On the aphides inhabiting *Pistacia terebinthus* and *P. lentiscus*, by L. Courchet.—Morphological researches on the family of Graminaceæ, by D. A. Godron.—On some plants gathered in the neighbourhood of Montpellier in 1877, by M. Duval Jouve.—Catalogue of the land- and river-molluscs of the Hérault department, by E. Dubrueil.—On the employment of collodion for obtaining microscopical sections, by M. Duval.—Note on the discovery of a layer of limnacidæ-marlstone (shell-marl) at Celleneuve, near Montpellier, by F. Fontannes.—On the reason of the occasional simultaneous occurrence of limestone plants and silica plants, by Ch. Contejean.

THE *Sitzungsberichte der naturwissenschaftlichen Gesellschaft Isis zu Dresden* (1878, part ii., July–December) contain the following papers of interest:—On the earthquake observed at Nolhac on July 24, 1878, by J. von Boxberg.—On the tertiary basin of Bilin, by Herr Deichmüller.—On the cones of *Glyptostrobus europæus*, Brongn., by Herr Engelhardt.—On the bed of the River Priessnitz, near Dresden, by the same.—On J. H. Schmick's work: the sun and moon as constructors of the earth's shell, by Clemens König. The reviewer condemns Herr Schmick's theory completely, and draws attention to its numerous weak points.—On the mineralogy and geology of the St. Gotthardt, by Herr Roscher.—On some abnormal cone formations in pines, by Dr. Nobbe.—On some Swedish plants, by Herr von Biedermann.—On some new results in prehistoric research, by Dr. Geinitz, sen.—On a light machine, by Dr. Töpler.—On an elementary derivation of the law of gravitation from Kepler's laws, by Herr Helm.—On an expedition to the Arctic Ocean and the White Sea, by Herr Baldauf.—On silicified

roots and other wooden objects found at Oberan, Tessen, and Okrylla, by Dr. H. Conwentz.—On the silicified woods from the diluvium of Kamenz, Saxony, by Dr. E. Geinitz.—On the general conception of space and its applicability in natural research, by Dr. A. Harnack.—On the electrometric appliances of the present day, by Dr. Töpler.

Journal de Physique, July.—On the optical figures of polychroic crystals, by M. Bertin.—On the figures presented by crystals having one optical axis, by M. Bertrand.—Noës' thermo-electric piles, by M. Niaudet.—Colours, the chromometer, and photography of colours, by M. Cros.

Gazetta Chimica Italiana., fasc. iv. and v.—On nicotine, by S. Andreoni.

SOCIETIES AND ACADEMIES

Geneva

Society of Physics and Natural History, February 6.—M. L. Lossier explained a special method which he has introduced for assays of gold.—M. Albert Rilliet gave an account of a research made by him and M. E. Ador on the hydrocarbons obtained by the action of the chloride of methyl on benzine in presence of chloride of aluminium.

February 20.—M. H. de Saussure described an apterous insect of Gaboon, whose mode of life is unknown, and which has been described under the name of *Hemimerus*. It has the remarkable characteristic of possessing a second lower lip provided with palpi, and several other characteristics make it an insect of an altogether special nature, difficult to classify in any of the known orders.

March 6.—M. Casimir de Candolle has studied the anatomy of the leaves of some cotyledons, and particularly the internal conformation of their petiole, or the principal nervure. This petiole shows in its centre a woody bundle presenting very varied forms—sometimes that of an arc, sometimes that of a complete ring. Besides this complete ring, there are frequently observed woody bundles placed outside the ring, and which M. de Candolle calls cortical; at other times bundles inside the ring, and which M. de Candolle calls intra-medullary.—M. Ph. Plantamour observed during the cyclone of February 20 a notable depression of level of the Lake of Geneva. The wind produced this effect of depression notwithstanding the diminution of atmospheric pressure indicated by the barometer, and which would tend to raise the level of the water. When the wind assumes the form of a whirlwind, it produces an aspiration instead of a depression. The rate of the cyclone referred to appears to have reached at least 24 metres per second.

March 20.—Prof. E. Plantamour presented a quarto volume entitled "Telegraphic delimitation of the difference of longitude between Geneva and Strasburg," published by himself and M. M. Löw. This operation, executed in 1876, resulted in a difference of 6m. 27·934s.—M. D. Colladon, on the occasion of very remarkable cases of *verglas* observed in Paris on January 20 and 23, recalled former cases described by him and others (see *Comptes Rendus*, t. lxxx. viii., March 31, 1879).

April 3.—M. Raoul Pictet communicated the continuation of his researches on the theory of heat. He admits that the amplitude of the oscillations of molecules around their position of equilibrium may be taken as a measure of heat, or as corresponding to the temperature. He explains by this definition the properties of fusibility of metals and the anomalies of Mariotte's law.—Prof. Brun described a curious case of poisoning in a child of two years, resulting from eating a combination of cabbage and figs. The cabbage must have produced a great abundance of lactic acid, which in presence of the glucose of the figs had produced buteric acid in sufficient abundance to cause the death of the child.

April 17.—Prof. Alph. Favre has found iron in the state of particles attractable by the magnet in all the earths and rocks of the country around Geneva which he has examined. This iron, in grains, not being soluble, cannot be considered in the analysis of arable soils, as profitable to vegetation. Hence erroneous conclusions resulting from these analyses, which suppose more iron than there is possible for vegetation. The origin of this iron is attributed in part to the *débris* of meteorites.

Paris

Academy of Sciences, July 28.—M. Daubrée in the chair.—The following papers were read:—Researches on the refraction of obscure heat (continuation), by M. Desains.—Note on the hydrate of chloral, by M. Wurtz.—Observations on the memoir of MM. Noble and Abel on explosive substances, by M. Berthelot.—On the theory of hail, according to MM. Oltramare and Colladon, by M. Faye. M. Boussingault also made some observations on the subject.—On the effect of electrical excitations applied to the muscular tissue of the heart, by M. Marey.—Memoir on the temperature of the air at the surface of the ground and of the earth to 36 m. depth, as also on the temperature of two soils, one exposed, the other covered with grass, during the year 1878, by MM. Ed. and H. Becquerel.—Researches on samarium, radicle of a new earth extracted from samarskite, by M. Lecoq de Boisbaudran.—MM. Georges Pouchet and S. Jourdain were then nominated candidates for the chair of Comparative Anatomy at the Natural History Museum, vacant through the death of M. Paul Gervais.—M. Daubrée then reported on the experimental researches of M. Stanislas Meunier, relating to the meteoric nickel-iron and native carburetted iron of Greenland.—Two memoirs were presented to the Academy, one by M. David, on the development of algebraic functions, the other by M. Poincaré, on the effect produced by the inhalation of nitrobenzole vapour.—On some observations of planets (198) and (200), made at the Marseilles Observatory, by M. Stephan.—On an application of rational mechanics to the theory of equations, by M. F. Lucas.—On the action of light on electric piles, by M. H. Pellat.—On the refrigerating action of air at high pressure, by M. A. Witz.—On the distillation of a heterogeneous liquid, by L. Troost.—On the quantities of organic matter in mineral waters, by G. Lechartier.—Thermo-chemical researches on the soluble alcaline sulphides, by M. Sabatier.—On the decomposition of sulphide of ammonium, by MM. R. Engel and A. Moitessier.—On the calcination of turnip-molasses, by M. C. Vincent.—On the influence of sugar injected into veins upon the secretion of urine, by MM. Ch. Richet and R. Moutard-Martin.—On the irritability of a muscle during the different periods of its contraction, by M. Richet.—On the discovery of medicaments and poisons in saliva, by M. Gabriel Pouchet.—Comparison of the influence of intravenous injections of chloral, chloroform, and ether, by M. Arloing.—On the lympho-glandular organs and the pancreas of vertebrates, by M. Renaut.—On some multinuclear animal and vegetable proto-organisms, by E. Maupas.—On the two great phases of the annual circulation of the atmosphere, by L. Brauet.—Experiments on milk-production, by M. Lami.—On the formations of the so-called "Dombes," by M. Nivet.—On the palm-wine of Laghouat, by M. Balland.

CONTENTS

THURSDAY, AUGUST 14, 1879

THE DISSOCIATION OF CHLORINE

DURING the past few years the well-known chemist, Prof. V. Meyer of Zurich, has rendered signal service to his brother workers by the introduction of numerous improvements in methods of determining vapour densities. At about the close of last year, in conjunction with Herr C. Meyer, he described a simpler method than any hitherto introduced, available for high temperatures, and yielding results of very considerable accuracy.

This method consisted in heating a vessel to a temperature at which the substance whose vapour density was to be determined was completely converted into gas, then introducing a small weighed quantity of the substance in question, and subsequently measuring, at the ordinary atmospheric temperature and pressure, the air displaced from the vessel by the vapour of the substance. In this manner, the volume of vapour, measured at the atmospheric temperature and pressure, generated by a known weight of substance is ascertained, and the density deduced from these data by a simple calculation. The great advantage of the method is that it does not require a knowledge of the temperature of the vapour, and the entire series of operations may be performed in a very short space of time.

The apparatus employed is also extremely simple, and consists of a cylindrical bulb of about 100 c.c. capacity, sealed to which is a glass tube about 6 mm. in diameter and 600 mm. long; this tube is widened out at the open end, so as to admit of the introduction of a caoutchouc stopper, and has a side tube, 1 mm. in diameter and 140 mm. long, sealed on to it about 100 mm. below the open end. The side tube is once bent nearly at right angles and the end slightly turned up, so that, when dipped into water, it will deliver gas into a graduated glass vessel inverted over it. For determinations at high temperatures the bulb is constructed of porcelain and is heated in a gas furnace; when operating at lower temperatures the bulb is heated either by means of a vapour bath or in a bath of molten lead. The operation consists in heating the bulb until it acquires a constant temperature, which is indicated by the non-appearance of air-bubbles at the orifice of the side tube which is plunged under water; the stopper is then removed, the weighed quantity of substance introduced and allowed to fall into the bulb, the stopper quickly reinserted, and the end of the side tube then brought under the measuring vessel; directly air ceases to issue from the extremity of the tube, the stopper is removed, and the air thus collected is afterwards measured in the usual manner. In the case of substances which undergo oxidation when heated in air, the air is first displaced from the apparatus by a current of pure nitrogen.

Operating in this manner, the Messrs. Meyer have determined the vapour density of a variety of inorganic compounds, such as indium chloride, stannous chloride, cuprous chloride, zinc chloride, ferric chloride, phosphorus pentasulphide, and arsenious anhydride, and have obtained results showing the molecular formulæ of these substances to be as follows:—

$$InCl_3,\ Sn_2Cl_4,\ Cu_2Cl_2,\ ZnCl_2,\ Fe_2Cl_6,\ P_2S_5,\ As_4O_6.$$

They then directed their attention to elementary bodies, and in a recent communication to the Berlin Chemical Society, they describe the results of experiments, showing that at a temperature as high as about 1,567° C. the molecular composition of mercury, oxygen, nitrogen, and sulphur is correctly represented by the formulæ—

$$Hg,\ O_2,\ N_2,\ S_2,$$

which are those generally adopted.

But with chlorine they obtained very different results. They employed platinous chloride as the source of this body, as it can be obtained perfectly dry and readily splits up into chlorine and platinum when moderately heated; a known weight of the chloride was introduced into the bulb in each experiment, the air having been previously expelled by a current of nitrogen. The numbers obtained in a first experiment at about 620° C. agreed with those required on the assumption that the chlorine molecule has the formula Cl_2, which is that generally accepted; but on determining the density at about 800° C. a lower number was obtained, and a still lower density resulted from experiments at about 1,028° C. and 1,242° C., but no further change of density was observed on making determinations at temperatures of about 1,392° C. and 1,567° C. The density (referred to air) observed at the various temperatures was as follows:—

Approximate temp.	Density.	
620°	2·42	2·46
808°	2·21	2·19
1028°	1·85	1·89
1242°	1·65	1·66
1392°	1·66	1·67
1567°	1·60	1·62

The density at about 1,200° and above, it will be observed, is two-thirds of the density at 600°; the change in volume undergone by chlorine when heated is therefore precisely similar to that undergone by oxygen in its passage from the condition of ozone to its ordinary condition, and it might therefore be supposed that a similar change had taken place. The researches of Sir B. Brodie have placed it beyond doubt that if we regard ordinary oxygen as having a diatomic molecule represented by the formula O_2, ozone has a triatomic molecule of the formula O_3, the conversion from ozone into oxygen being represented by the equation—

$$2O_3 = 3O_2.$$

Inasmuch, however, as chlorine has the atomic weight 35·4, such an explanation of the change in density of this gas is inadmissible; it would only be possible if what we at present regard as the atom of chlorine is a compound of 3 sub-atoms each of the weight $\frac{35 \cdot 4}{3}$. The only other explanation, however, which can be given is that chlorine after all is not an element but a compound of at least two elements which are dissociated by heat. Mr. Watson Smith in a letter from Zurich, printed in the *Chemical News* of last week, states that the Messrs. Meyer incline to this latter explanation, and that in all probability *oxygen is one of the components of chlorine*; we hear also from another source that they have actually separated oxygen from it, but hitherto no description of this part of the investigation has reached us.

It needs not to be pointed out that such a discovery as is here foreshadowed is of the highest importance. There can hardly be a doubt that if chlorine be found to give way

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so easily, other so-called elements, and especially those which, like bromine and iodine, are closely related to chlorine, will not long resist the attacks to which they will now be subjected; indeed, the Messrs. Mayer already state in their paper that the behaviour of iodine is similar to that of chlorine.

In concluding this notice I cannot refrain from stating that to my knowledge Mr. Lockyer has for several months past been engaged in the spectroscopic investigation of the non-metals, and that he has repeatedly assured me that the views he has already published with regard to the metals are equally applicable to the non-metals. He has shown me, moreover, that with the spark at a particular tension the *red line of oxygen* is one of the most prominent lines in the spectrum of chlorine, the freedom from which of admixed air and moisture is attested by the absence of the characteristic nitrogen and hydrogen lines. Mr. Lockyer regards this as confirmatory of the Meyers' discovery.

HENRY E. ARMSTRONG

SCIENCE IN THE ARGENTINE REPUBLIC

Description physique de la République Argentine; d'après des Observations personelles et étrangères. Par le Dr. H. Burmeister, Directeur du Museo Público de Buénos-Ayres. Tome Cinquième: Lépidoptères, 1re Partie, contenant les Diurnes, Crépusculaires et Bombycoides. (Buénos-Ayres, Paris, et Halle, 1878, 8vo.; Atlas de xxiv.[1] Planches, 1879, 4to.)

IN commencing a notice of this work it is impossible to avoid an expression of admiration for the persistent energy displayed by its septuagenarian author. Half a century has elapsed since his "inaugural dissertation" (on an entomological subject) was read at Halle, and during this time a continuous flow of valuable works and articles has appeared from his pen, not only in the long period of his professorship at Halle but also since he became permanently located in Buenos Ayres. Now, at an age when most men who have attained it have lapsed into "the sere and yellow leaf," so far as laborious work is concerned, we find him undertaking a gigantic enterprise, of which entomology is only a portion. All those who have had occasion to consult his former works will heartily acquiesce in the hope that he may live to complete this.

Without doubt the most valuable features of the volume under consideration consist in the numerous direct observations by the author and his son, on the structure and life-histories of the insects treated upon, from living subjects, in contradistinction to what may be termed mere museum work. In one respect disappointment will be felt. It might have been expected that an author of such vast experience, and with such admirable opportunities, would have been explicit in expression of opinion on those important subjects of philosophical inquiry that now occupy the attention of all entomologists, and for which South America furnishes such notable materials.

On the question of mimicry he appears to be absolutely silent, contenting himself by occasional remarks on the fact of resemblances, but without comment. On the theory of evolution he is scarcely more explicit, and the only remarks that bear, even indirectly, on this subject are those that appear in the "Avertissement" to the description of the plates, where he says:—

"I am unable to share the views of those specialists who augment the number of species indefinitely by slight variations; on the contrary, I am a partisan of the opinion, well founded on experience, that each species, although from a scientific point of view fixed and up to a certain point invariable, is forced to modify itself under different external influences of climate and food, and that these influences may, to a certain extent, alter some of the subordinate specific qualities. This faculty will be greater in proportion as the territory over which the species is spread may be more vast, and one will only find altogether invariable, those local species that have never quitted their place of origin. From this restricted point of view I am a partisan of the theory of the variability of species."

From this it will naturally be understood that our author is no advocate for the reckless creation of "species" now so alarmingly put in practice, to apparently little other purpose than the gratification of the vanity of those species-makers who wish to see their names attached to an endless list of synonyms. That the author is right in his reductions in the case of those species inhabiting the region immediately under his observation, possibly few only will dispute, and, above all, not those who know the exactitude of his critical powers in this respect; but other reductions concerning forms from the more northern parts of the South American Continent may be open to question, unless on the standpoint taken as to the value of the term "species."

The existence in the southern portion of the vast continent of South America of certain genera belonging to the nearctic fauna, has not escaped the author's notice. He alludes to the subject more than once, even in connection with the purely Argentine fauna, but without further comment.

The introductory anatomical portion is, as might have been expected, of the utmost value, and may be studied with advantage by students of Lepidoptera generally. Exception might probably be taken to too great importance being attached to the covering of scales as an attribute of the order. Instances (p. 1) might have been cited of the existence of "scales" in other orders, such as the well-known *Podura* and *Thysanura*, many *Curculionidæ*, some *Trichoptera*, certain forms of *Psocidæ*, &c., if not on the trunk itself, at any rate on the wings and other appendages.[1] An entire chapter is devoted to the structure of the scales, and the conclusion arrived at is that the well-known longitudinal striations exist only on the *upper* surface; if the writer mistake not, microscopists have arrived at the same conclusion from an examination of that favourite "test-object," the "*Podura*-scale."

As in all his works, the author shows himself a rigid advocate for "purity of nomenclature," and does not hesitate to adopt the spelling he considers the more correct. On the question of priority we read (p. 110): "The strict observance of priority of nomenclature appears to me an exaggeration of scientific law; I prefer names given by masters, such as Linné, Fabricius, Latreille, &c., to those of simply collectors, as Cramer, Drury Donovan, &c., following the axiom *au mérite la couronne*." Regarding these words from a sentimental point of view,

[1] Of these only sixteen have as yet appeared.

[1] The neuropterous genus, *Coniopteryx*, cited by the author (p. 1, footnote), has no scales; the covering is apparently a waxy secretion, soluble in ether.

few will object; but the possibility of applying them in the present state of science is, and probably will be, fiercely contested; and it may be justly urged that the descriptions in the works of the masters he alludes to, would not, in many cases, have been recognisable had the types not been in existence, or had it not been for the beautiful iconographic works of those authors whom he somewhat derogatively terms "simply collectors."

Turning to the purely systematic arrangement of the author, we find the *Lepidoptera* divided into *Rhopalocera* and *Heterocera*, or into *Diurna*, *Crepuscularia*, *Nocturna*, and *Microlepidoptera*. This is broad grouping, and we shall be curious to see, in a future volume, how it is proposed to get over the difficulties of the last-named. On some points of minor arrangement the author's views will be regarded as rank heresy by most entomologists of the present day; and the most notable of these are the positions assigned to those anomalous groups known as the *Castniadæ* and *Uraniadæ*, which are boldly united with the *Rhopalocera*, as groups 10 and 11 of that division, in opposition to the ideas of almost every one, and notably to those of Boisduval and Westwood (the latter author's recent memoir on the genus *Castnia*, and others, in the *Trans.* Linn. Soc., ser. 2, Zoology, vol. i., 1877, is alluded to in the text attached to the plates). It is scarcely to be expected that the reasons given for this course will be found convincing to the majority; could it be so, the arrangement would be hailed with satisfaction by those numerous collectors who, confining themselves to "butterflies" only, are now debarred from adding to their stores some of the most beautiful insects that exist. The *Crepuscularia* are divided into *Sphingidæ* and *Sesiadæ*; the *Zygænidæ* are not represented in the author's faunistic region, but the *Glaucopidæ*, often associated with them, are transferred to the *Bombycoides*, and head that section. Many other points might be alluded to in which the author departs from common practice in systematic views, but it is only fair to him to state that, in all cases, he gives the fullest reasons for adopting the course, however insufficient they may appear to others; but this notice has already become too lengthy, and they must be left to the discretion of specialists, all of whom must of necessity possess the work. An inconsiderable number of new species are described.

The plates (only an uncoloured copy of the atlas is before us) are admirably executed, the drawings having been made by the author himself, and lithographed at Berlin, a course which has added greatly to their value, owing to the present impossibility of finding sufficiently skilled engravers in Buenos Ayres; at the same time it has naturally caused delay. The value attached to the beautiful representations of the transformations of many species, cannot be too highly estimated, and the explanatory text is very ample, containing also new matter, not appearing in the body of the work. R. McLachlan

MODERN METEOROLOGY

Modern Meteorology. A Series of Six Lectures Delivered under the Auspices of the Meteorological Society in 1878. (London: Edward Stanford, 1879.)

THE publication of "The Origin of Species" and the introduction of the spectroscope as an implement of research, have not wrought perhaps a greater revolution in the biological and physical sciences than has the invention of weather charts in the younger science of meteorology. One has only to look back a quarter of a century at the writings of meteorologists to see the radical change which has been brought about, not merely as regards the nomenclature of the science but even as regards the standpoint from which the whole phenomena of atmospheric movements are looked at. It was to diffuse more generally a knowledge of this change that the Council of the Meteorological Society arranged the delivery of these six lectures, which on the whole faithfully portray to the reader the present state of meteorology in its outstanding features.

From its important bearing on the future of meteorology in the British Islands, we note with great satisfaction the remark in the lecture on "Air Temperature" that the same pattern of thermometer box, viz., that known as the Stevenson, has been adopted at the stations of both the English and Scottish Meteorological Societies, to which may be added the stations of the Meteorological Office; and we heartily endorse the opinion expressed by the lecturer, Mr. J. Knox Laughton, that on such a vital subject as the observation of the temperature, absolute uniformity of pattern which is secured by the adoption of Stevenson's box, is better even than Utopian excellence.

The lecture by Mr. Strachan on the "Barometer and its Uses" is characterised by a full and exact knowledge of the instrument and its history, and a correct estimation of the present state of the problems relating to atmospheric pressure with which he has occasion to deal. His examination, for instance, of various theories which have been broached in explanation of the diurnal range of the barometer is acute and satisfactory, and from that examination he shows that a hypothesis yet remains to be framed which shall account for the diurnal oscillations of the barometer. The truth is, none who have yet attempted to account for the diurnal barometric oscillations—one of the widest spread and constant of terrestrial phenomena—have had before them sufficiently the facts of observation such as might indicate, with the requisite fulness of detail, the influence of geographical position on the problem which it is sought to solve.

Mr. Strachan throws out incidentally a valuable hint regarding the forecasts of our European weather which are wired from America. He says (p. 95):—

"It is worth while inquiring how our American friends manage this business. They are not very willing to show their hands, as the saying is. However, we may surmise how it is done. They have active agents who make extracts of the logs of all the steamers directly they arrive in New York, and by means of these extracts they can follow up all the storms which occur in our parallels. Thus it may often happen that information of storms is obtained by the *Herald* before they have had time to reach western Europe. The *Herald* at once flashes the news by telegraph. We get the telegram surely and speedily and the storm, if it does not vanish in the meantime, shortly afterward."

Whether this be the practice of the expert of the *New York Herald* or not, there cannot be a doubt that we have here an indication of the way in which substantial advance may be made in our system of weather forecasting, viz., by some central authority in America at once receiving by telegraph extracts from the logs of all vessels

directly they arrive at Atlantic ports; by the aid of which, warnings may be framed, and wired to Europe, of such storms as may appear to threaten its coasts. In this connection it is not possible to overestimate the importance of a telegraph wire to Farö and Iceland, by which warnings of many storms thus seen approaching our coasts, could be issued one or two days earlier at least than at present.

Mr. Clement Ley contributes an extremely interesting, and in some respects a very valuable lecture, on clouds considered as weather-signs, accompanied with nine well-executed illustrations in colours. Mr. Ley has been a close observer of the forms and movements of clouds almost from infancy, being even then strongly under the fascinating spell of their mystery and beauty. Habits of close and accurate observation were thus formed and the tendency has become so inveterate that to this day a twelfth part of his waking existence is spent in observing the clouds. For several years he has given the closest observation and study to a strict examination of the relations of different clouds to cyclones, anticyclones, and to thunderstorms, in other words, to changes of weather. It is the results of this examination which form the most valuable part of the lecture, these results being of the utmost importance to the isolated observer, who may take the trouble to follow up the subject, in enabling him with better success to forecast the weather though aided only by his own observations. A treatment of the subject with greater fulness than is possible in a single lecture would be warmly welcomed by meteorologists and all others interested in weather.

In one of the lectures it is stated with much emphasis that "the great need of every branch of meteorology is neither more observations nor more money (though neither of these is to be despised), but more brains, more hard workers, more deep thinkers." In a certain sense this is true, but in a wider sense it does not represent the most pressing needs of meteorology. In the last lecture of the series, Mr. Scott justly remarks that as regards synoptic work on a large scale, we may look our critics in the face and boldly ask for more observations, no matter how our shelves may be bending beneath the weight of undiscussed records. The truth is, those who are engaged with original researches in meteorology find themselves ever and anon seriously hampered, if not completely arrested in their work for want of the data of observation. We are unaware that any systems of observation at present exist which could furnish, for example, the data for the determination of the horizontal or vertical meteorological gradients, or for ascertaining how far and with what modifications the influence of the sea extends inland. Nay even, though thanks mainly to the indomitable energy of Mr. Symons, there are upwards of 2,000 gauges recording the rainfall of the British Isles, the number, not to mention positions, of these gauges, are too inadequate to admit of even a rude guess being formed as to the quantity of vapour abstracted from the air in the form of rain or snow during any of the storms that sweep across the country. Much less can we, without largely increased observation, give an indication of the varying hygrometric and thermometric states of the atmospheric currents to windward and leeward of the regions of large rainfall in Great Britain. Meteorologists, no less than astronomers, had cause to deplore a great loss in the death of Leverrier, the keenest sighted of physicists and prince of organisers of systems of observation, one of his last works being the establishment of a system of observation, by which the propagation of rain, hail, and other weather phenomena, could be followed from commune to commune over France. With such results as may be expected from this system, and from General Myer's magnificent scheme of monthly meteorological charts for the whole of the northern hemisphere, which will also bring into the field thousands of fresh observers, physical data leading towards the solution of some of the great meteorological problems will be supplied, without which observational data, mere brain-work—such is the complexity of the problems to be dealt with—would prove either useless or positively mischievous.

OUR BOOK SHELF

Farming for Pleasure and Profit. By Arthur Roland. Edited by W. H. Ablett. (London: Chapman and Hall, 1879.)

THIS small book has the defects as well as the merits which might have been expected in the work of an amateur farmer. His own practice seems usually sound and sometimes ingenious, but his explanations and advice cannot always be safely trusted. When he tells us what he has himself done, we listen with attention; when he offers us page after page full of antiquated veterinary nostrums, we cannot feel edified. We did not know till now that foot-and-mouth disease was *epidemic;* the cause and cure of apthæ (*sic*) is not quite adequately given on p. 205; and we should certainly hesitate before adopting the following treatment (p. 191) for a cow suffering from moor-ill:—"Some insert a seton in the dewlap and take away ten pounds of blood in very severe cases. A recipe has been given to administer, in very obstinate ones, six drachms of aloes, twelve ounces of sulphur, and sixteen drops of croton oil, the first day, in addition to a blood-letting of ten ounces," and so on with further directions of the heroic order. When Mr. Roland tells us of all the breeds of cows, of the cheese-factory system, and of a dozen other matters, of which, so far as we can learn, he has had no actual experience, we feel that his space and our time might have been more profitably occupied. That a good deal of information, and not a little amusement into the bargain, may be got out of Mr. Roland's book, is not to be denied, however. Whether "a great number of persons who would gladly supplement their incomes, if they could see their way clear to do it, by entering into rural occupations which are congenial to their tastes," would be able to follow the lead of Mr. Roland in his farming practice may be gravely doubted. It is not every amateur pig-feeder who will be so lucky as to find "a good pork-butcher, doing a superior trade, and ready to give nearly thirty per cent. more than could be obtained by selling young porkers haphazard." Nor will the amateur pea-grower always be able to adopt the following excellent and economical plan of disposing of his produce. Mr. Roland stows his green peas ready shelled in two flat wicker baskets under the first-class railway carriage in which he daily travels to town. He finds that the landlord of the hotel where he dines in the city will give him one shilling a quart for these peas, fetching them from the cloak-room of the station where they have been deposited. This ingenious method of marketing hardly admits, however, of general adoption; and, moreover, the railway authorities might have something to say about this plan of evading payment of carriage. Mr. Roland's previous attempts to dispose of cabbages and turnips (pp. 16 and 17) were less satisfactory in their

pecuniary results, though more accordant with ordinary experience. Let the reader of these eight chapters on "Farming for Pleasure and Profit" omit everything except what is given on the personal authority of the author, and he will gain a number of useful hints showing how to economise the vegetable food raised on a small farm, and to make amateur agriculture in some ways less financially disastrous than is usually the case. But we shall not find a complete system of practice here; nor do we discover any hints, however remote, of the chemical composition and physiological functions of food; and we look, too, in vain for any recognition of recent advances in our scientific knowledge as to methods of manuring and cropping.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Theory and Laws of the Microphone

Two hypotheses have been projected to explain the action of the microphone. One is molecular exclusively, and supposes that the molecules of certain conducting bodies contract and dilate under sonorous vibrations. Changes of *density* correspond with an increase or diminution of the resistance of the circuit. This hypothesis renders the phenomena analogous to those which selenium presents under the influence of light and radiant heat. The other explanation, partly mechanical and partly molecular, is the result of a discovery made some time since by M. du Moncel, according to whom the increase or diminution in resistance is due to changes of *pressure* at the points of electric contact. These changes of pressure are effected by the vibration of the air; hence the cause and the effect are similar.

As the result of numerous experiments, I shall endeavour to prove that, while one of these theories is altogether erroneous, the other is only superficially true.

1. If the piece of charcoal is fixed with wax without any pressure, the microphone remains silent under the strongest sonorous impulses, which would be impossible were the movement molecular.

2. The microphone may be inclosed in a vacuous chamber without altering the result; in this case waves of air can have no effect upon the density of the charcoal.

3. It is impossible to construct a microphone from one solid piece of charcoal, presenting stable contact, such as would not interfere with molecular action, but which prevents the sonorous waves from affecting the currents which traverse the carbon.

These afford sufficient reasons for rejecting any simply molecular theory.

Now against the second theory.

1. Lateral pressure on a compact electric conductor excites no microphonic action.

2. Longitudinal pressure within certain limits on the charcoal does not injure the apparatus.

3. An apparatus can be made to yield microphonic effects where there is no alteration of pressure. Pressure, therefore, is no essential cause of microphonic sounds, though it may be an accidental one.

In all microphones where contact is made at one point only, the current is interrupted whenever this point of contact is broken; a musical sound is heard when the two points are in vibration. This microphone, like Reis's telephone, can only transmit musical sounds. I have obtained the best results from a steel point and a membrane of a stretched bladder. A strip of tin-foil is gummed to the membrane to insure electric contact. With a single small cell of bichromate of potash a song can be heard through a whole room.

To transmit articulate sound it is necessary that the number of points of contact, the difference in this number during action, and the resultant changes of resistance, should be greater. The interruption of the current is then only partial; it becomes "undulatory." To this description belong the principal microphone of Mr. Hughes, Edison's carbon telephone, the transmitting telephone of two graphite pencils of MM. Pollard and Garnier, Helleren, &c.

A convenient form of microphone, which transmits words, music, the noise of a watch, &c., has the membrane of india-rubber stretched tight by a thin strip of tin-foil which unites the carbon underneath with the screw. The vibrations of the membrane throw a greater or less number of points into contact; all the shades of expression in the voice may be transmitted, owing to the rapidity of these small changes. It is the changes in the points of contact which here play the chief part, and there is little doubt that here we have the quality as well as the intensity of a sound reproduced.

This explains many of the microphonic actions, but not all. Here is one case:—

If the microphone is formed of two cylindrical pieces of charcoal, the points of contact cannot be made to vary by pressure, supposing the cylindrical shape to be perfect. The action here is due to the distance the current has to traverse the bad conductor; for the membrane to which these charcoal points are attached approaches or recedes from them when vibrating. The liquid telephone transmitters of Bell, Gray, and Salet rest upon the same principle where a change of resistance in the circuit is due to the varying depth of liquid traversed by the current. This, equally with the theory of the points of contact, explains the microphone of M. Righi, where a metallic disk is plunged into a powder of lead and silver mixed.

The next class of instruments consists of those where the current is created, and varies under the influence of microphonic electrodes (by this I mean the opposite parts of a microphone, whether in direct or indirect contact). Such are microphonic batteries. Each battery can act as a microphone if one of its poles is movable. Two ends of iron wire, dipped in ordinary water, and brought together, give signs of microphonic action. One pole is attached to the vibrating membrane, and dips at its extremity into the liquid, while the other pole remains there constantly. The current only passes when the movable pole is in the liquid. On singing into the tube the vibrations of the membrane cause the pole, which is also a microphonic electrode, to dip into the liquid, setting up chemical action as many times a second as there are vibrations in the note sung. If the pole touches the liquid constantly, the current is constant, but varies in intensity for four reasons: the different number of points exposed to electrolytic action; the different number of points of electric contact; the different number of the points of resistance of the liquid; and the different number of the points of approach of one pole to the other; all these are due to the movement of one of the microphonic electrodes.

There is yet another class of microphones. In all the instruments hitherto constructed, the direction of the current remains the same, but it is possible to make it change, thus introducing another difference in the manner of its action.

In all the possible forms of microphone, the chief causes of the action are:—a mechanical movement of its parts, a change in the points of conductivity, a change of resistance; these three essentials result from one another. The expression "points of conductivity" includes not only the points of contact, but also the route taken by the current.

The next point of consideration is the so-called increase of sound by a microphone, but this is not the case. All sounds are weakened by the microphone, and are transmitted only when the source of sound is in direct contact with the microphone or its stand. The microphone is less an instrument for transmitting sound than for transforming mechanical movement into sound. The intensity of a sound is, therefore, directly proportional to the energy of the mechanical movement accompanying the sonorous waves, or as a necessary consequence to the changes of resistance in the microphone. The distinctness of articulate sounds, transmitted by the microphone, is in inverse proportion to their intensity; for a loud sound tends to interrupt completely the current, and thus to prevent the transmission of articulate sounds. This is the chief hindrance to increasing, at pleasure, the loudness of the sound. The loudness of the sound is also dependent on the strength of the current.

Other experiments prove that the rapidity of movement of the parts of a microphone also affects very considerably the resultant sound, as well with a strong, as with a feeble current. Changes in resistance and in current strength are not sufficient, unless made rapidly, to excite microphonic action.

Great as is the invention of Mr. Hughes, the microphone reveals no new property of matter, neither does it show the direct effect of sonorous waves upon partially conducting bodies.

Lemberg University JULIAN OCHOROWICZ

"The Rights of an Animal"

I AM sorry that my review appears to have caused Mr. Nicholson some annoyance, but am not surprised that in his rejoinder he has not attempted to meet any one of my criticisms. As he now expressly avoids the well-known ambiguity which attaches to the word "same," he clearly avows his meaning to be what in my review I supposed it could not be, viz., that animals have "in all respects *identical* rights of life and liberty with man." If this proposition is seriously stated, it does not require a "writer capable of reviewing an ethical essay" to see that it cannot possibly have a place in any such essay, properly so called. And in supposing that this could not be the fundamental proposition which Mr. Nicholson intended to maintain, I did not "forget" that the animals which he allows "to be killed or worked were only allowed to come into life for these purposes." For if the rights of animals are *identical* with those of men, and if the breeding of animals for the purpose of killing them morally justifies the butcher in taking their lives, it certainly follows, for instance, that a physiologist would be morally justified in vivisecting his own children on the plea that it was for this purpose that he had begotten them. Where such is the necessary ethical conclusion, it is clear that the ethical premises by which it is evolved must be erroneous.

As regard the crustaceans, seeing that they are not "harmful animals," I chose them as a type of the class of animals which Mr. Nicholson plainly says it is in his opinion morally wrong to kill.

I may add that I omitted to mention the "plea" to which his letter in NATURE refers, because it had no relation to the opinion I was criticising—the opinion, namely, that harmless animals ought not to be killed for food. Here, however, is the "plea." "It may be answered that if none of these (*i.e.*, crustaceans) were killed more land animals would be killed for food; that their death allows more land animals to be kept alive for other purposes; and that this sharing of risks is only fair to the latter, the more so as they stand higher in point of intelligence and usefulness. Is this plea sound?" I can scarcely suppose that Mr. Nicholson will thank me even now for reproducing so feeble an argument, and in any case am quite sure that the latter, whatever it is worth, has no reference to the abstract principle which I was examining.

The relevancy of Mr. Nicholson's "protest" I fail to perceive. That "principle" and "self-interest" are not synonymous is sufficiently obvious, but I do not see how this consideration affects my charge of "inconsistency of principle." I simply pointed out that if we have a moral right to slay a harmful animal in order to better our own condition, it involves an inconsistency of principle to deny that we have a similar right to slay a harmless animal, if by so doing we can secure a similar end. And this obvious criticism is not affected by the irrelevant remark that "principle" and "self-interest" are not synonymous.

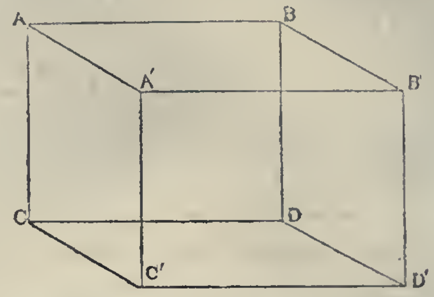
Again, as I was reviewing Mr. Nicholson's essay, and not Mr. Lawrence's book, I deemed it unnecessary to allude to the "reprints" from the latter, more especially as I saw nothing in these reprints of a nature either "interesting" or instructive. If my omission in this respect is calculated to damage the sale of the essay which I reviewed, I can only express my sorrow that such should be the case; but as I further omitted to state that the pages of the essay are small and very widely leaded, the idea which I conveyed of the size of the book as a whole was certainly not an inaccurate one.

I have taken the trouble to reply to the above remonstrance thus fully because I am conscious of having done what every honest reviewer ought to do, viz., to state what he thinks and to give his reasons for what he states. But as the result in this case has been to dissatisfy the author reviewed, I think it is now desirable to prove, by subscribing my name, that I have no personal *animus* against him. GEORGE J. ROMANES

A Suggestion on the Action of the Oblique Muscles of the Eye-ball

THE action of the so-called oblique muscles of the eye-ball has been a *quæstio vexata* amongst anatomists for a long time, but I, in all submission, venture to suggest the following experiment which *may* be entertained mathematically. I speak of my own eyes, and the method in which I endeavour to use my oblique muscles, according to authorities.

Suppose I draw a skeleton cube at haphazard thus—



and I *concentrate* my vision on the anterior plane of this cube (A′ B′ C′ D′) in the sketch; if I put in action (according to what we believe to be the action) the superior and inferior oblique muscles, the projection is immediately altered, and the plane A B C D is instantly the anterior? Pardon my apparent ignorance of physics, but may not some of your many correspondents, without ignoring my anatomical knowledge, make the statement a basis for research. A good explanation for the condition I must confess has escaped me?

It may throw some light on the question as to whether the oblique muscles definitely alter the optical functions of the eye, which is certainly a matter of the greatest practical interest.

EDWARD BELLAMY

Natural History Notes from Burmah

1. *The Dorian.*—The Dorian is a large capsular fruit with four or five loculamenta, each containing one seed which is covered with a layer of pulp, the part eaten. The rind, as well as the seeds, emits a strong odour of sulphide of methyl.

Dorian eaters say that the excellency of the fruit consists in the succession of exquisite flavours experienced in eating it. From my own experiments I believe this to be due to a reaction of the nerves of taste, analogous to that of the retina, which causes the images of objects to appear in their complementary colours when the eye is suddenly shut.

2. It is asserted that the weaver bird has the habit of fixing fire-flies to the side of its nest by means of a lump of mud, for the purpose of illuminating its nest at night. I have not observed it myself. Perhaps some of your readers may have seen or heard of the practice.

3. *Ants.*—There is here a species of small black ant, of which there occur gigantic specimens differing from the others only in size. They seem to act as the elephants of the community, carrying loads that the small ones cannot lift. Sometimes one of these "elephants" may be seen returning to the nest with several of the ordinary size clinging on its back.

Once while taking lunch in the image cave at Maulmain, we observed several large black ants wandering about. A chicken bone thrown in their path was soon discovered, and a messenger was despatched to the nest, from which a compact body of ants soon issued. But by some mistake they took the wrong direction from the nest, and proceeded towards a fragment of plaster that had fallen from one of the statues and lay on the floor of the cave. This they examined all over, and then returned to the nest in a less orderly manner than they had marched out, but at the entrance some other ants met them, who must somehow have given them the proper direction, for they at once changed their course towards the bone, which was soon covered with ants. I think this observation has some bearing on the way in which ants communicate. It is clear that the messenger's signs were misunderstood, and they went so straight to the bit of plaster that it appeared to me that they must have seen it, for sight is the only sense that could have been deceived. The distance was about four feet, and this occurred near the entrance to the cave, so there was light enough if their range of vision was great enough. R. ROMANIS

Government High School, Rangoon

Pigeons and Weather Warnings

In the *Standard* of the 5th instant is an account of a pigeon-race from Penzance to London, a distance of 270 miles, which was done by one bird in 5 hours 34 minutes, and by another in 5 hours and 59 minutes. Might not the carrier-pigeon be employed to bring accounts of the weather 300, 400, or even 500 miles out in the Atlantic, being despatched on outward voyages by ships leaving ports such as Queenstown, Southampton, Dartmouth, Plymouth, or Falmouth? The great difficulty in our system of weather-warnings is that storms reach us unannounced over the Atlantic, because stations are of course out of the question on the ocean. If the daily sailings of steamers from various ports could be utilised by means of pigeons, this void might to some degree be filled. If it be true that many storms come to us along the course of the Gulf Stream, a branch of it (Rennell's Current) would be met a little beyond the Scilly Islands, say 100 miles farther out, or about 150 miles from Falmouth. If a bird brought a weather-warning in three hours from what would appear to be an important point, it would surely advance matters a good deal. A great part of England can be warned from the Irish coast, but Scotland has no advance-guard of this sort. Steamers leaving Greenock for America could carry pigeons and send warnings back, thus giving Scotland some protection. R.

Putney, August 5

Napoleon III. and the Nicaraguan Canal

At p. 249 of Nature, vol. xx. it is made to appear as if the circumstance of the connection of the late Emperor of the French with the scheme of Central American canalisation through Nicaragua, was *quite unknown* to the public. But it is well known that Prince Louis N. Bonaparte, whilst at Ham, was in communication with Don Francisco Castillon, envoy to Louis Phillippe from the Nicaraguan Government upon this subject. After the escape of Louis Napoleon from France, he publicly advocated the project of the Nicaraguan Canal at the Institution of Civil Engineers, London. (*Vide Proceedings* I. C. E., 1847, vol. vi. p. 427; *vide* "The Gate of the Pacific," by Commander Bedford Pim, pp. 118, *et seq.*) S. P. O.

Vitality of the Common Snail

At the beginning of July last year, I placed a couple of the *Helix aspersa* into a closed pot of earth immediately after copulation. They soon sealed themselves up, and so remained till the middle of May of this year, when it was discovered that of one of them that had died not a vestige was left except the empty shell. The other had shrunk to about a third its former bulk, but on being moistened and supplied with food, soon began to eat and to thrive. It had to trust largely to chance for its provender, but notwithstanding this, by the end of two months it was as big as its present quarters would allow it to be. The natural thing would have been to secrete more shell, for the animal was not full grown. Instead of this, however, it burrowed in the ground, and fell to laying eggs, the greater part of which have hatched out—a little colony of vigorous young snails. Had their parent been kept supplied with food and water after impregnation, they would, of course, have begun life a year ago. I wonder how high up in the animal scale such temporary suspension of the earliest stages of development is possible?

Trinity College, Cambridge, August 7 James Ward

OUR ASTRONOMICAL COLUMN

Variable Stars.—It may be hoped that some amateur in the other hemisphere—the class of observation is hardly suited to the professional astronomer, considering the work that remains to be accomplished in the southern heavens—may be keeping in view Lacaille's star, μ Doradûs, which is certainly variable to a great extent, and in a very long period. In the Catalogue published by the British Association founded upon the observations in Lacaille's *Cœlum Australe Stelliferum*, the star is rated 5 m., though in the Catalogue at the end of this work we find it 6 m., the estimate applying to the year 1751, and this is also the magnitude noted by Brisbane about 1825. The variability of the star was first shown by the late Capt. Jacob's observations at Madras early in 1850; he found no such conspicuous star as Lacaille and Brisbane had observed, but fixed the position of one which nearly agrees with the Paramatta place, and which was estimated 9·5; this star was reobserved at Madras in 1855 and rated 9·2. The next we hear of it is from Moesta, who, observing at Santiago, states (*Astron. Nach.*, No. 1,545) that from February, 1860, to January, 1865, he had found it 8½ or 9 on Argelander's scale. Finally Mr. Stone observed the star at the Cape of Good Hope in 1875 and estimated it a *seventh* magnitude, which should induce a close watch upon it at the present time. The star was formerly credited with a very sensible proper motion, but it would appear from the modern observations that this arose from an error in Lacaille; thus, bringing up all places to 1875·0 we have—

				Right Ascension. h. m. s.		North Polar distance. ° ′ ″
Lacaille	1751	December	...	5 6 2·2	...	151 57 3
Brisbane	1825		...	5 5 51·42	...	151 57 55·2
Jacob	1850		...	53·16	...	59·3
—	1855		...	53·34	...	57·0
Stone	1875		...	52·74	...	59·3

There appears a suspicion of a similar case with regard to the star Brisbane 5935, observed once at Paramatta and estimated 6 m. This star does not occur in Lacaille, but it was looked for in 1850 by Jacob, who found only one 9·10 m. near the place given by Brisbane, differing however 4s. in R.A. and 1′ 18″ in N.P.D. Mr. Stone's nearest star is Lacaille 7093. If the objects observed by Brisbane and Jacob are identical, proper motion as well as variability will enter into the case.

The observations of Julius Schmidt at Athens in 1878 again show great irregularity in the variation of R. Scuti, the mean period he obtained for that year being 62·3 days, instead of 71·1 days, as determined by Prof. Schönfeld, and which was satisfactory in 1869. The last epochs determined at Athens in 1878 were, for a maximum, November 8, and for a minimum, October 11. The mean period of α Herculis in the past year was found to be 97·3 days, but the period varied from 86 to 113 days. In such instances it is obvious that observations, made as continuously as possible can alone determine whether the fluctuations follow any definite law.

The Minor Planets.—The discovery of a small planet by Prof. Peters at Clinton, N.Y., on July 28, raises the number of known members of the group to *two hundred*, the object detected by the same astronomer on July 16 proving to be an old acquaintance,—No. 77 (*Frigga*), which had not been recognised for upwards of ten years. Of the planets discovered during the present year, No. 193 (Coggia, February 28) has been named *Ambrosia*, No. 196 (Peters, May 17), *Philomela*, and No. 198 (Borrelly, June 13), *Ampella*.

The Satellites Mimas and Hyperion.—According to elements which have been previously used in this column, *Mimas* would be found at its greatest eastern elongation on August 20, at 13h. 47m. G.M.T., distant 30″ from Saturn's centre or 8″ from the extremity of the ring; the period of revolution may be assumed 0·94243d. It appears difficult to make reliable prediction of the position of *Hyperion* from present uncertainty as to the motion of the line of apsides. Prof. Asaph Hall adopts a retrograde motion of less than 3° annually, but there are indications that the true motion may be in the opposite direction, and to a much greater amount. Mr. Marth, who has devoted so much time and labour to the motions of the satellites of Saturn, was of opinion some ten years since that the revolution of the line of apsides of *Hyperion* would be found to be very rapid, through the powerful action of the great satellite *Titan*. Three periods of *Hyperion* are almost exactly equal to four periods of *Titan*, if we adopt Prof. Hall's period for the former.

GEOGRAPHICAL NOTES

On August 1 the International Conference of the Alpine Clubs was opened at Geneva, in the building of the Conservatorium. The Alpinists were very numerous, and the meeting was really an international one, as all nations have sent their representatives. M. Albert Freundler occupied the chair, and Mr. C. E. Matthews, president of the English Alpine Club, Prof. Talbert, vice-president of the Central Directory of the French Alpine Clubs, M. Budden, from Florence, Prof. Ed. Richter, delegate of the German and Austrian Alpenverein, and Prof. Charles R. Cross, from Boston, were elected vice-presidents. The subjects submitted for discussion were: 1. The improvements to be made in Alpine inns; 2. The regulations concerning shelters; 3. The instruction and examination of guides; 4. The possibility of a common action of the Alpine Clubs for obtaining from the railway companies a reduction of fares for Alpinists who travel in groups; and 5. Sanction by all clubs of the resolutions passed by some of them as to inns and guides. The discussion was alternated with communications of a more general interest. M. Henri de Saussure read a communication on the state of the Boston (U.S.) Appalachian Club, whose activity is remarkable as shown by numerous publications of a high scientific and artistic value. In the discussion on shelters M. Binet-Hentsch proposed to make the roofs of the Alpine shelters of bituminated paper; the experiment which was made by the government of the canton of Graubunden, proves these roofs to be excellent. M. Durier gave a brilliant account of his exploration of Etna, which he made eight months before the eruption of this year. The Rev. M. Denza, director of the Observatory of Moncalieri, read a paper on mountain meteorology. The memoir, which aimed to interest Alpine climbers in meteorology and to point out the services they could render to science during their travels, gave an account of what is done by Italian Alpine Clubs for meteorology, no less than one hundred meteorological stations having been erected by these clubs, fourteen of them at very high altitudes. The memoir gave rise to a very interesting discussion, during which Prof. Alphonse Favre spoke of the necessity of measurements of the motion of glaciers; and the Italian and Austrian representatives explained what is done in that direction in their countries. M. Henri de Saussure read three unpublished letters, written to his illustrious ancestor, Horace Bénédict de Saussure, as to his ascent of Mont-Blanc. The papers of that time having spoken of his project, his friends wrote to him numerous letters to dissuade him from the perilous undertaking. The Abbé Landriani entreats him in the name of science to take care of himself, and not to risk his precious life, and the Prince de Ligne, a very gallant officer, advises him to undertake a regular siege of the giant mountain; several relays of workmen, with pick-axes and shovels, should "level the asperities of the road, and so," he writes, "going up some ten fathoms per day, you could reach the summit after a six weeks' work." As to the instruction and the examination of the guides, M. Talbert recommends such institutions as that of Interlaken, in Switzerland; besides, he proposes to found libraries for the guides and to publish a manual like that just issued by the president of the Italian Alpine Club. As to the reduction on tickets, the French railways have made a reduction of fifty per cent. for all Alpinists travelling either in groups or separately, so that no less than 130 members went to the Conference of Geneva. No special resolution was taken on the fifth question, but it was resolved to maintain an active correspondence between the directors of all Alpine Clubs.

The *Times* Berlin correspondent telegraphs that news has been received that Prof. Nordenskjöld has succeeded in getting out of Behring Straits. We are inclined to doubt the accuracy of this statement; we have reason to believe, at least, that no such news has been received by Mr. Oscar Dickson, of Gothenburg, who would most likely be the first to whom Nordenskjöld would communicate his success.

The efforts which Commander Cheyne has been making for some time past to organise a new Arctic Expedition promise to be successful. Committees have been established all over the country, with a central Arctic committee in London, located in the rooms of the Literary Society. Lord Derby has subscribed 100*l*. towards the expedition, and his example has been followed by Mr. Samuel Budget. We believe that balloons will form an important part of the equipment of the expedition. The Bank of England, it is stated, has consented to open an account under the title of "The New British Arctic Expedition."

Two well-known African travellers will again start for the Dark Continent during the autumn: Dr. W. Junker will visit the Egyptian Soudan, while Dr. Oscar Lenz, the eminent Ogowe traveller, will go to Morocco by order of the German African Society. This society is making arrangements to establish in Morocco a school for African travellers, as it were; the country, although comparatively near, being yet very scantily investigated. Moreover, the young travellers will there get thoroughly accustomed to Mohammedan life, and the Society will thus acquire well-trained representatives to be sent afterwards to various parts of Central Africa.

The Admiralty have issued a hydrographic notice respecting the Siam coast in the Bay of Bengal, the information in which is derived from the notes of Commander A. D. Taylor, Superintendent of the Marine Survey of India, and from remarks by Commander A. de Richelieu, of the Siamese Navy. Among other items of geographical information contained in it, we learn that the town of Takuapah is situated on the Takuapah or Kopah River, in the Siamese province of Muang Takuapah, in 8° 48′ N. lat., about fifteen miles from the sea. It is surrounded by tin mines and large plantations, and its inhabitants are mostly Chinese. The only export is tin, of which a considerable quantity is sent away, and indeed, next to Puket, it is the largest tin-exporting place on the coast of Siam. The houses are mostly of bamboo and atap, though some few are built of brick. There are several mining villages along the banks of the river, and the country about Takuapah and to the northward is undulating and mountainous. Pia Sima, the highest mountain, about ten miles east of Koh Rah, culminates in three peaks of nearly equal elevation, and is upwards of 3,500 feet above the sea.

We understand that a work by Mr. V. Ball, of the Geological Survey of India entitled "Jungle Life in India, or the Journeys and Journals of an Indian Geologist" will appear shortly. The volume will contain a popular account of the author's observations, extending over a period of fourteen years, on the geology, zoology, botany, and ethnology of Western Bengal, the Central Provinces, the Himalayas, Beluchistan, and Afghanistan, the Andaman and Nicobar Islands, and Burmah, interspersed with which are numerous anecdotes and sporting adventures. A number of beautifully executed woodcuts and a map, the former illustrative of the scenery and inhabitants of these comparatively little-known regions, will aid, it is believed, in commending the volume to a large and varied circle of readers. In a series of appendices some of the more strictly scientific topics are dealt with. The publishers are Messrs. Thomas De la Rue and Co.

Recent news from South Australia states that a plentiful supply of fresh water has been obtained on the tube-well principle on the Mount Lofty Range, 1,700 feet above the Adelaide plains.

A PARAGRAPH recently went the round of English and foreign papers and geographical journals, purporting to give the population of Japan according to a census taken in 1878. We have the best authority for stating that no census has been taken in Japan since 1875, and that the numbers given as for 1878 were really those of 1875.

NORDENSKJÖLD'S ARCTIC EXPEDITION

LETTERS have just come to hand from the Swedish North-east Passage Expedition in the neighbourhood of Behring Straits. The latest date is February 20, when all was as well as possible. We take the following details from Prof. Nordenskjöld's report, addressed to Mr. Oscar Dickson, of Gothenburg. The *Vega* and the *Lena* parted company on August 27 at the mouth of the River Lena, the former shaping her course for the New Siberian Islands. The air was calm, but for the most part overcast; the temperature as high as 4° C., and the sea free from ice. On the 28th Semenoffskj or Stolbovoj, the most western of the New Siberian Islands, was sighted, and on the 30th Liakhoff's Island, but a landing was not effected on account of the shallowness of the water in its vicinity. On the 31st Svjatoi Nos was passed without difficulty, the weather being fine, and the land in the neighbourhood free of snow. The water was slightly salt, and had a temperature rising to 4° C. The weather continued fine until September 1, the wind being southerly, and the temperature of the air in the shade 5·6° C. On the night before the second the wind became northerly, and the temperature fell to – 1° C. The following night there was a large fall of snow. Next day the Bear Islands were reached. Tschaun Bay was passed on the night before September 6, and Cape Schelagskoj reached by 4 A.M. The nights now began to be so dark, and the sea so filled with ice, that the *Vega* had to lie-to at night, generally anchored to a large ground ice. Two boats resembling the *umiaks* of the Eskimo were now seen filled with natives, the first that had been encountered since the expedition left Chabarova at Jugor Schar. They were received in a friendly way, but none of them could speak Russian or any other language intelligible to the Swedes. A boy could, however, count ten in English, showing that the intercourse with American whalers was greater than with Russian merchants. On September 6 and 7 the *Vega* steamed slowly along in a narrow open and ice-free channel along the coast. On the 8th a landing was effected near a Tchuktch encampment, where the Swedes were received in a very hospitable manner. They found in one tent reindeer flesh boiling in a large pot of cast iron. Another start was made on September 6, but a fog compelled the Swedes to lie-to till the 10th. Many excursions were made on land. The strand was formed of sand which, immediately above high water-mark, was covered with luxuriant turf. Farther inland, a range of very high hills was visible, and beyond that, at a considerable distance from the coast, snow-covered mountain-tops. The low land consists of sand and clay beds, evidently raised above the level of the sea very recently. No erratic blocks were to be seen, from the absence of which Nordenskjöld concludes that there is not at present to the north of this any such glacial land as Greenland. The rocks here were non-fossiliferous. Few land plants could be collected on account of the advanced season of the year, and in the sea Dr. Kjellman dredged for algæ in vain. On land many graves with burned bones were found. On the night before September 10 the sea was covered with a very thick crust of newly-frozen ice, but the *Vega* continued her course. On the 12th, after passing Irkaipi, or the North Cape, the vessel had to be anchored to a block of ice, where she lay till the 18th, when another advance was made. After lying-to from September 24 to 26, the *Vega* reached Cape Onman, and on the 27th Koljutschin Bay. The following day the cape to the east of this bay was passed, and the *Vega* lay-to, anchored to a ground ice, waiting for a favourable change, but no such change took place. Northerly winds heaped greater and greater masses of drift ice along the coast, and soon extinguished all hope of getting free before the summer of this year.

SIR THOMAS MACLEAR, F.R.S.

THE last Cape mail brought intelligence of the death of Sir Thomas Maclear, which took place at his residence, Mowbray, near Capetown, on July 14.

Sir Thomas Maclear was a son of the late Mr. James Maclear, of the County of Tyrone, and was educated at Winchester. He was originally destined for the medical profession, but, after settling at Biggleswade, we find him occupying himself in astronomical pursuits. He joined the Astronomical Society in 1828, and erected a small observatory at Biggleswade, which contained the Wollaston telescope, lent by the Society, with which he observed many occultations and other phenomena. He also engaged upon astronomical calculations, chiefly for the prediction of occultations. In conjunction with Henderson he computed the circumstances of the occultations of Aldebaran for ten European observatories in 1829–31, and himself calculated such of the occultations in 1833, about 100 in number, as were visible at Greenwich, for the supplement to the *Nautical Almanac* of that year. On Henderson's retirement from the direction of the Royal Observatory at the Cape of Good Hope, Maclear was appointed his successor, and entered upon the office in January 1834. Of the great number of observations made during his superintendence a portion only have as yet been published. He entered upon an undertaking of the importance of which there cannot be two opinions—the verification of Lacaille's arc of the meridian, but it was allowed to disorganise the regular work of the observatory to a serious extent. The observations by Maclear and his assistant in 1834 were speedily reduced and published, and various series of observations of comets when beyond reach at the northern observatories, have appeared in the *Memoirs* of the Royal Astronomical Society, where also have been published his determinations of the parallax of α and β Centauri, the latter of which had not been previously investigated, and there are memoirs on other subjects. The field work for the re-measurement of Lacaille's arc was completed in 1847, but from various delays the results were not published until 1866, when they appeared in two quarto volumes, under the editorship of Sir George Airy. The time occupied upon this work prevented the reduction and publication of the meridian observations; so that on Mr. Stone's arrival at the Cape in 1870 (as successor to Maclear on his retirement) he states he found himself "confronted with the results of thirty-six years of miscellaneous observing, in all stages of reduction."

Acting upon his official instructions Mr. Stone completed the reductions and published in several volumes the results of the observations with the new transit-circle from 1856 to 1860 inclusive; there remain still unpublished the observations from 1834 to 1855 with the old instruments, and those from 1861 to 1869 with the new one. Of the large number accumulated in the former period, the places of southern stars will still be of value for proper motions, but Mr. Stone has expressed a doubt whether "the immense number of observations of well-known stars" made with the old instruments would now repay the labour of reduction.

Maclear was knighted in 1860. He had been a Fellow of the Royal Society since 1831, and was elected a Correspondent of the Institute of France in 1863 in place of the American astronomer Bond; in 1867 the Lalande medal was awarded him by the Academy of Sciences, and in 1869 he received one of the Royal medals annually adjudged by the Royal Society.

We are informed that at Sir Thomas Maclear's funeral, on July 16, all the principal residents in the colony were present. The Cape Parliament has passed a resolution or memorandum acknowledging the work he did for the colony.

A POINT AFFECTING THE DIFFUSION OF THE GASES OF THE ATMOSPHERE IN RELATION TO HEALTH

THE great importance in relation to health of the part played by the internal motion of gases, as indicated by the now established and admirably simple kinetic theory, would seem scarcely to receive adequate appreciation. The old and vaguely developed statical idea of a stagnant atmosphere with molecules at rest, has given place to the opposite view of a high activity of motion, even when the atmosphere appears to the senses to be still. By this motion noxious vapours or gases, instead of remaining stagnant, are rapidly scattered by diffusion, and thereby rendered harmless. The part apparently played here by inequality of molecular *velocity* (dependent on inequality of molecular mass) in contributing to this end, would seem scarcely to have received the attention it appears to deserve. In Prof. Tait's work, "Lectures on some Recent Advances in Physical Science" (p. 237, second edition), reference is made to the diffusion of the gases of the atmosphere under the kinetic theory, and here it would seem as if the influence of the *inequality* of the normal velocity of the molecules of the different gases of the atmosphere (dependent on inequality of molecular mass) had not been taken into account, and hence it would appear as if the gases in their mutual diffusion were regarded as subject to the pure contingencies of chance, as they would be if the velocities of the molecules were equal (or their masses equal); this necessarily leading to some rather startling conclusions, which make the continuance of life and health (as dependent on the equable mixture of the constituents of the atmosphere) a matter more or less dependent on contingency or accident. The passage in question runs as follows :—

"There is another extremely important point of this statistical question as to the particles of gases which I must carefully explain; and it is this, how it happens that in the enormous bulk of the whole atmosphere of the earth these particles of oxygen and nitrogen, moving about amongst one another, should not by chance, at some place or other, operate on one another in such a way that in some particular cubic inch the particles of nitrogen might for a moment expel from it all the particles of oxygen, so that in virtue of the great extent of the earth's atmosphere, compared with the size of a particle of gas, there might be at some definite instant a region filled mainly with nitrogen, and other regions filled mainly with oxygen. Now the beauty of this statistical method is that it explains to us how such an event, though perfectly possible, can never occur. It is a thing which is itself absolutely possible, but it never can occur in practice, because the probability of its occurrence is so exceedingly small. There is a probability (numerically measurable) for everything which is possible, but if that probability (reckoned in numbers) is as small as the probability of the accident we are considering, we never expect to find it occur. And not only do we never expect to find it at any time, but we can say boldly from experience that it is never met with at all, however long our observations are conducted, or through however great an extent of space we conduct them. If you had originally in a box divided into two equal parts, nitrogen in the one part and oxygen in the other, and then allowed them to mix with one another, the probability that in any assigned time you could find all the nitrogen back again in the space where it was originally, and all the oxygen back again in the space where it was originally, is certainly one which can be measured, but it is one which is so infinitesimally small that we know perfectly by experience that it can never be realised."

The above appears a somewhat unsatisfactory conclusion to contemplate, and there would seem to be something scarcely consistent in the inference that an event which is itself absolutely possible never can occur in practice, "because the probability of its occurrence is so exceedingly small." For we know from the doctrine of probabilities that an event of chance (if possible at all) *must* occur, if the range of time be not restricted, or at least its probability approaches with *indefinite* closeness to absolute certainty in that case. That the probability, for example, of suffocation in a room [taking the above illustration of a box on a large scale] within a given range of time, by the oxygen separating itself sufficiently from the nitrogen, could be rigidly calculated, seems scarcely pleasant to contemplate, however remote the contingency might be, and it is hardly satisfactory to think that the contingency of such an event approaches with indefinite nearness to absolute certainty if an adequate *time* be conceded. The very fact that considering the vast extent of the atmosphere and the range of historic time, no record whatever exists of any irregularity having been detected in the constitution of the atmosphere, would surely be strong argument for the existence of some physical cause tending to prevent such irregularity from occurring, and removing it from the pure contingencies of chance. The above quotation that—"we can boldly say from experience that it [*i.e.* the irregularity] is never met with at all, however long our observations are conducted"—would surely tend to prove that some preventive means existed.

If the molecules of nitrogen and oxygen of a mass of air confined in a room were supposed subject to the pure contingencies of chance in their mutual actions in diffusion, they would be comparable to a number of equal perfectly elastic black and white balls imagined to be moving and colliding freely among themselves, or left to their own dynamics in an analogous manner. In this case there would evidently be practically an infinite number of chances against the molecules of the two gases (represented by the two differently coloured sets of balls) from becoming uniformly diffused through the room; indeed the probability of this event would be exactly the same as the probability of the oxygen being all separated in one part of the room and the nitrogen in the other (or in analogy all the black balls separated from the white); for we know that, according to the doctrine of probabilities, every *assigned* arrangement for all the balls is equally probable.

I venture to suggest that the inequality in the *mean velocity* of the molecules of the two gases (dependent on the inequality of the masses of the molecules) plays an important part here. If this particular point has been considered elsewhere (without my knowledge), I may still perhaps give an elementary analysis of the problem, as it has occurred to me. It may be remarked that on account of the simplicity of the kinetic theory, its problems frequently admit of elementary treatment, and it will at least be admitted that wherever this is practicable, perspicuity does not lose thereby. We will imagine for illustration a portion (say spherical shaped) of pure oxygen gas to be at a given instant of time surrounded by an atmosphere of hydrogen. [We may neglect the existence of gravity, for simplicity, as it does not affect the point with which we have to deal.] Then diffusion at once commences. The molecules of hydrogen which have one-sixteenth less mass, are known to possess a normal velocity four times that of the molecules of oxygen. The molecules of hydrogen by their own normal motion will therefore rush into this spherical space occupied by the oxygen, four times as fast as the molecules of oxygen can move out by their natural motion. Owing to this inequality in the rate of exchange of places of the two gases, the mass of gas occupying the spherical space will begin to increase in density, and (for

a converse cause) the gas surrounding the spherical space will diminish in density to a corresponding amount. This initial irregularity of density will cause an initial irregularity of pressure, which will tend at once forcibly to readjust itself, and will do so by the gaseous mixture within the spherical space expanding,[1] and an exchange of energy (or "heat") taking place between the two gases—which abnormal state of things can only cease when the two gases become uniformly mixed, and consequently the dynamical conditions become symmetrical in all parts of the mixture. Owing to the absence of dynamical equilibrium in the case of two gases having different molecular velocities, *unless* the gases are uniformly mixed, there is therefore a forcible dynamical tendency to produce uniform mixture, and to maintain it against disturbing causes, when once the mixture has become uniform. When the molecules of the two gases possess unequal normal velocities (attendant on inequality of mass), it is evident that the distribution of velocities can be symmetrical throughout the mixture, *only* in that case where the mixture is uniform. If, on the other hand, the molecules of the two gases possessed the *same* normal velocities (due to equality of molecular mass), there would be no dynamical cause for any particular mixture more than another, or every assigned mixture (regular or irregular) would be equally probable: for the distribution of the velocities would be symmetrical or uniform, whatever the mixture might be. Taking our illustration of the spherical portion of gas, and supposing the gas surrounding it (though chemically different) to have *equal* molecular velocity, then the exchange of molecules between the gases would take place at the same rate, and consequently there would be no disturbance of the equilibrium of pressure at all, but one mixture would be as possible as another, and the distribution of the velocities would be symmetrical whatever the mixture might be.[2] In fact, it would resemble the case of the diffusion of two portions of one and the same gas into each other.

Thus it would appear that the fact of the molecules of the constituent gases of the atmosphere possessing unequal normal velocities (due to inequality of molecular mass) tends, through the dynamic action of the molecules, to produce and maintain forcibly a uniform mixture of these gases, and to prevent those detrimental irregularities of mixture that would inevitably occur (by a sufficient range of time and space), if the constituent gases of the atmosphere were of *equal* molecular masses, and consequently diffusion were brought under the pure contingencies of chance.

I have ventured to call attention to this point from its apparent importance, and as the passage above quoted would have the appearance at least of treating the problem as one of pure chances, or as if the influence of the *inequality* in molecular velocity had not been taken into account, but I shall be glad to accept correction if I am wrong.

The fact of the two gases of the atmosphere possessing unequal molecular masses would evidently seem to be of importance as a means for scattering and thereby rendering harmless, noxious vapours and gases which are emitted into the atmosphere. For even if the particular vapour (in a rare case) happened to be of the same molecular mass as one of the constituents of the atmosphere, it must differ from that of the other constituent, and thus a dynamical cause for dispersion exists. The considerable inequality in molecular mass of the most prevalent deleterious ingredient emitted in combustion and in the course of animal life (carbonic acid) thus ensures its dispersion.

In a paper published in the *Phil. Mag.* for April, 1875, by Lord Rayleigh—"On the Work that may be gained during the Mixing of Gases"—it was pointed out that work may be derived from gases in an unmixed state, and a special method for effecting this end was described. In two papers communicated by me to NATURE (vol. xvii. pp. 31 and 202), I, being at that time unaware of Lord Rayleigh's memoir, indicated a simple mechanical means of deriving work from unmixed gases by the use of porous diaphragms. If we imagine a cylinder, into the piston of which a disk or diaphragm of some porous substance (say plumbago) is fixed, and that two gases of unequal molecular masses (oxygen and hydrogen, for instance) are introduced into the opposite compartments of the cylinder, then diffusion commences in the known manner through the porous diaphragm. Owing to the inequality in the normal velocities of the molecules of the two gases, they pass through the pores of the diaphragm at unequal rates, thereby entailing an inequality of pressure on the two sides of the diaphragm. If then the piston (containing the diaphragm) be suddenly released, it will be driven towards the opposite end of the cylinder, and work may thus be derived. [A simple automatic device for continuing the work by a constant supply of gas was described in NATURE, vol. xvii. p. 204.] Although the work is here derived in a self-acting manner, solely at the expense of the normal temperature heat possessed by the gas, yet this would not apparently be out of harmony with the second law of thermodynamics [as the writer at first supposed]; for it appears that for such to be the case, the process would require to be a *reversible* one, or the gases would require to be restored again to their original unmixed state. But if it were possible that the gases could effect this themselves, or become unmixed by their mere action upon each other, and the probability, that in any assigned time we should find all the oxygen back again in the one half of the cylinder, where it was originally, and all the hydrogen back again in the other half, is one which can be measured (however remote this probability might be); then we should have a possible means of deriving work at the expense of normal temperature heat by a process that was self-reversible. Hence this result to which we are led would serve to confirm the above view, viz., that when gases are of *unequal* molecular masses, there is a forcible dynamical tendency to keep them mixed, or to prevent the gases from becoming separated again when once they have become mixed.

There would seem to be another consideration bearing directly on the above case. It was a law enunciated by Dalton that when gases of different kinds are placed in the same vessel, "each gas behaves to the other as if it were a vacuum." This, when viewed by the light of the modern dynamical theory, is no doubt true as regards the fact that the total pressure on the sides of the vessel is the sum of the pressures which each gas would exert independently if placed by itself in the vessel. But if the expression "that one gas behaves to another as a vacuum" were taken to refer to the *arrangement* of the gas in the vessel, then some modification would appear to be required in the statement of the law in the case where the different gases are of *equal* molecular masses (as also where portions of gas of the same kind are successively introduced into the vessel). For it appears from the above considerations that gases do not *necessarily* become uniformly mixed by the action of diffusion, excepting when the gases are of *unequal* molecular masses. For portions of gas of equal molecular masses behave to each other as portions of gas of the same kind. If we imagine (merely for illustration) the molecules of a portion of gas to be *marked*, and this portion of gas to be introduced into a vessel where already gas of the same kind exists, then it is evident that there

[1] The expansion may be seen by inclosing the oxygen in any elastic porous envelope, capable of expansion, and through which diffusion can freely take place. It may be observed that unmixed gases (of *unequal* molecular masses, of course) are known to possess a capacity for work, which ceases when the gases become uniformly mixed.

[2] It is conceivable that although the mean velocities or masses might be the same, the mean length of path of the molecules of the two gases might be slightly different. We must therefore either suppose a case where it is the same, or if minute exactness be desired, take it into account.

are an indefinite number of positions these marked molecules (representing the portion of introduced gas) could take up in the vessel, consistent with equilibrium, and there would be (practically) an infinite number of chances against the portion of introduced gas arranging itself as in a vacuum: for to do this, the marked molecules (composing the portion of gas) would require to arrange themselves in such a way that their mean distance is everywhere the same throughout the vessel, a contingency almost infinitely unlikely. What applies to marked molecules applies to chemically different molecules of *equal* mass, or which are *dynamically* similar. Hence it would follow that portions of gas of the same kind, or portions of chemically different gases of equal molecular mass could not be said "to behave to each other as vacua," in regard to *arrangement*. On the other hand, where the gases have unequal molecular masses there is (as we have seen) a forcible dynamical tendency for the gases to diffuse themselves symmetrically through each other, so that each gas behaves to the other as a vacuum, each gas becoming uniformly diffused through the vessel, as if it existed alone in a vacuum. The successive introduction into a vessel of portions of gas of the same kind (or of portions of chemically different gases of equal molecular mass) may be compared to the introduction into any closed space of successive sets of equal differently coloured perfectly elastic balls (the balls being supposed left in free motion among each other in analogy with the molecules of a gas), when evidently no one arrangement of the different coloured balls in the closed space (at any given instant) could be said to be more probable than another, and it would be extremely unlikely that the sets of coloured balls should "behave to each other as vacua," in the sense of each set diffusing itself symmetrically through the closed space, as it would do in a vacuum. But if the sets of balls were of *unequal* masses [in analogy to gases of unequal molecular masses], then no doubt the different sets would behave to each other as vacua, or each set would forcibly tend to arrange itself according to strict dynamical principles, so as to pervade uniformly the entire closed space, precisely as it would do a vacuum.

S. TOLVER PRESTON

OBSERVATIONS ON THE PHYSICAL GEOGRAPHY AND GEOLOGY OF MADAGASCAR

ALTHOUGH Madagascar is known to be the third largest island in the world, its actual size and extent is not very generally understood. It is easy to see how misconception on this point arises, for in maps the island is usually seen only in connection with Africa, and that great continent is so large that it dwarfs by comparison with itself everything in its near neighbourhood, so that the really large island sheltering under its south-eastern side appears but an inconsiderable appendage to its vast neighbour. If, however, we take a good-sized map of Madagascar, and put by its side the outline, to the same scale, of another country with whose dimensions we are familiar, such, for instance, as England, we begin to realise how important an island it is as regards size, being nearly 1,000 miles long[1] by about 250 in average breadth, so that it is nearly four times as large as England and Wales.

During the last ten years much light has been thrown upon the physical geography of Madagascar, principally through the researches of M. Alfred Grandidier, and the numerous exploratory journeys made in various parts of the country by missionaries and others. Until a very recent period there was no reliable map of the island; a number of mountain ranges were shown in positions where no such geographical features are to be found, and the physical geography was completely misunderstood. But it is now quite clear that instead of a "central mountain chain," as described in most histories and gazetteers, there is *an elevated mountainous region*, which, however, does not occupy the centre of the island, but is more to the east and north, leaving a considerable extent of country to the west, and all beyond the 23rd parallel of south latitude, at a much lower level above the sea. Broadly speaking, therefore, Madagascar consists of two great divisions, viz., (1) an elevated interior region raised from 3,000 to 5,000 feet above the sea-level; and (2) a comparatively level country surrounding it, not much exceeding 400 or 500 feet in elevation, and most extensive in the west and south.

The elevated region is largely composed of primary and crystalline rocks. Lines of hills traverse it in all directions, but they do not rise to a very great height, the highest points in the country, the peaks of the Ankàratra group of mountains, being a little under 9,000 feet above the sea-level. A very large extent of this portion of Madagascar is covered with bright red clay, through which the granite and basaltic rocks protrude. But there are also extensive rice-plains, especially near the capital cities of the two chief provinces, where there is a rich black alluvial soil; and it can hardly be doubted that some at least of these plains, from their perfect level, out of which the red clay hills rise like islands, have formerly been the beds of extensive lakes, subsequently drained, possibly by slight changes in the level through subterranean action.

A good deal of this portion of Madagascar is bare and somewhat dreary-looking country. The long rolling moor-like hills are only covered with a coarse grass, which becomes very brown and dry towards the close of the seven months' rainless season; but the hollows and river-valleys are often filled with a luxuriant tropical vegetation, and, wherever there is population, with the bright green of the rice-fields. There is, nevertheless, an element of grandeur in the landscape, from the great extent of country visible from many points in the clear, pure atmosphere, which renders very distant objects wonderfully sharp and distinct. And many portions of the central region possess still greater claims to admiration from its picturesque mountain scenery.

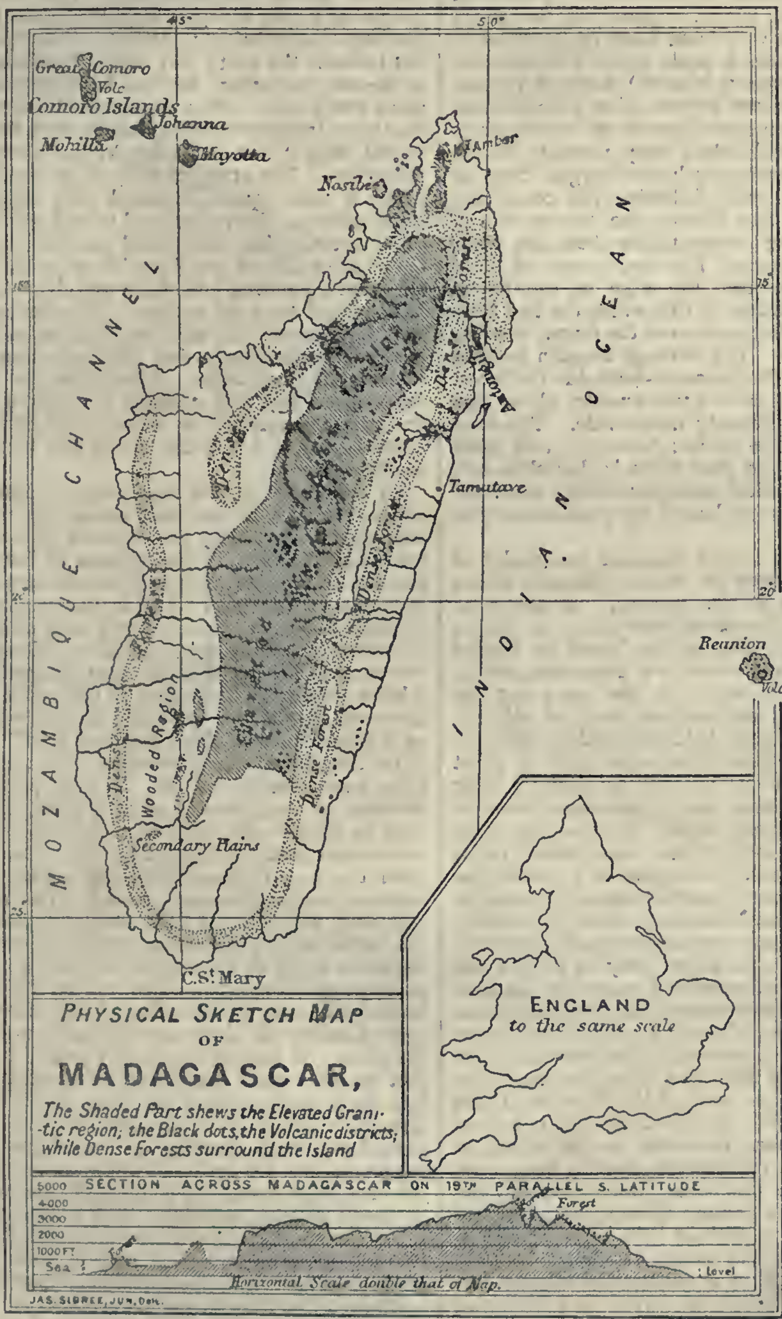
In the southern Bétsiléo country, the grand and varied forms of the mountains filled me with an exultant kind of delight. To the south was a crowd of mountain-tops, peak beyond peak, with the greatest variety of outline: one had the appearance of a colossal truncated spire, another had a jagged saw-like ridge, another was like a pyramid with successive steps, and another an enormous dome. Their summits were never long free from clouds, and many of the peaks must be at least 3,000 feet above the plain.

Sections taken by the aneroid across this elevated region from east to west at the latitude of the capital show that it has a depression in the centre, the edges on either side being considerably higher than the country between them. At some points this height of 4,000 to 5,000 feet is gained by a series of steps from the maritime plains, each range of hills rising higher and higher, while at other points it descends almost at one steep slope for nearly 3,000 feet. The water-shed is not in the centre of the island, but is much nearer the eastern side. Through the eastern wall many of the rivers cut their way by magnificent gorges, amidst dense forest, finding their way to the sea by a succession of rapids and cataracts, and occasionally by stupendous falls, as in the case of the Màtitànana river, which descends at one plunge 500 or 600 feet. Some of the western rivers, also, are said to form grand waterfalls, particularly that of the Mania, whose sound is reported to be heard at a distance of two days' journey, *i.e.*, about forty to fifty miles.

The lower region of Madagascar consists of extensive plains only a few hundred feet above the sea-level, but there are at least three prominent chains of hills traversing it from north to south, one of which appears nearly

[1] More exactly, 975 miles.

continuous in a very straight line for above 600 miles. The eastern side of the island is for the greater part of its extent without any bay or inlet, but the north-western side is deeply indented with large bays, into which the chief rivers fall. This part of the coast is bold and mountainous, and some of the finest scenery in Madagascar is to be found here, as the northern extremity of the volcanic region forms several very grand mountains, particularly the one called Amber or Ambòhitra. This is said to be about 6,000 feet high, and from its isolated position in the low country surrounding it, is a remarkably majestic hill as seen from every direction, as well as from far out to sea.[1] It has three summits, and its sides are clothed with impenetrable woods.



South-west of this mountain is a remarkable rock-fortress of the tribe inhabiting this portion of the country, who are called Antankàrana, that is, "the people of the rocks." It is an enormous, lofty, and precipitous rock, having an elevation of nearly 1,000 feet, and covering an area of about eight square miles. Its sides are so steep that they cannot be climbed unless artificial means are used, and it is thickly wooded wherever trees can possibly grow. The only entrance into the interior of the rock, which is full of caves, is by means of a subterranean passage, a portion of which is extremely narrow, allowing only a single person to pass along it at a time, and has on each side of it deep water.

The other principal group of mountains in Madagascar

[1] According to a French engineer's estimate, it considerably exceeds the above given altitude, being, so he says, 2,700 metres high.

is the great mass of elevated peaks called Ankàratra, in the central province. This has hardly the grand appearance of Mount Amber (although it considerably exceeds the latter in absolute height), since it rises from the elevated region of Imérina, which is at the capital about 4,000 feet above the sea-level. Ankàratra is nevertheless a noble group of hills, and is the most conspicuous feature of the landscape over a considerable portion of the central regions of the island. There are five or six principal summits, which vary from 8,000 to 9,000 feet in height, the most lofty one, a peak called Tsiàfajàvona ("that which the mists cannot climb"), being 8,950 feet above the sea-level, and is the highest point in the island.

Another interesting physical feature of Madagascar, which has only been made clear very recently, is the existence of an almost continuous belt of virgin forest all round the island, and generally following the coast-line. This forest-belt divides into two on the eastern side of the country, leaving a long narrow valley about 250 miles long between the two lines. The uppermost of these clothes the slopes which form the edge of the upper plateau of the island. North of this valley the two lines unite, and here is the widest portion of the forest, it being about forty miles across. The average breadth is from fifteen to twenty miles. On the north-west side the forest is not continuous, but the extremities overlap about 100 miles, leaving an opening seventy miles wide. The total length of this forest must be about 2,300 miles, and much of this is yet unexplored, so that there is doubtless still much of interest in botanical science awaiting research. Besides the forest-belt a good deal of the plain country to the west is well wooded.

A third fact of interest in the physical geography of Madagascar is the evidence of recent volcanic action throughout a great part of the country. It has been known for several years that there were signs of this on the north-west coast, and that in the island of Nòsibé and the adjacent mainland there are numerous extinct craters and much igneous rock. A few years ago the Rev. T. Campbell pointed out evident traces of volcanic agency in the district near the Ankàratra hills. He says: "It seemed as if the whole place were once a great smeltery, from the enormous number of clinkers lying about. There are altogether five mountains all near to each other, which have been active volcanoes at some remote period; each has one of its sides melted down and the inside hollowed out. The flow of lava looks as if it had been some immense reservoir bursting its banks, and the water dashing and foaming through, bearing everything away with it, or covering the plain beneath."

In a journey I took to the Lake Itàsy in 1866, I was struck with the number of truncated cones in the hills surrounding the lake. But extensive journeys made more recently in various directions have revealed the existence of a very widespread and powerful subterraneous action, probably extending almost unbroken from the south-east to the north-west and extreme north of Madagascar. There seems reason to suspect that this volcanic belt is part of a line which has its eastern extremity in the island of Réunion, where there is a volcano still showing occasional signs of activity; while the other (north-western) extremity passes through the Comoro Group (the islands of which consist of grand masses of lofty volcanic mountains), and terminates in the island of Great Comoro, where also, as in Réunion, is a still active volcano. It would seem as if the subterranean forces had expended their energy in the intermediate space, for there is no active volcano in Madagascar, while at each end of the line their presence is still occasionally felt. There are, however, signs of not altogether extinct forces in Madagascar in the slight earthquake-shocks which are felt almost every year, and in the hot springs of various kinds which occur in many parts of the country.

A large number of extinct volcanoes are found west of Lake Itàsy. These are thus described by Dr. Mullens :—"When we ascended the lofty hill overhanging the western end of the lake, crater after crater met our astonished gaze. There were forty in all, of which we were sure; we think there were others beyond to the north." "Fifty miles further south we came on the volcanoes again. We climbed a lofty rounded hill called Ivòko, and then found that we were on the crater wall. The inner hollow was a quarter of a mile wide, the height of the wall above the level country outside being 1,100 feet. Two lava streams went out towards the south and west; three small craters were at the foot, and others, large and conspicuous, were around us on every side. Close by, another huge crater, Iatsìfitra, had its opening towards the north, and the lava that had issued from it was fresh, black, and sharp, as if broken yesterday. But stranger still, at its eastern side was a plain, a mile square, covered with heaps of lava, like stone cottages, fortresses, and ruined palaces. I counted thirty greater piles, and noted numberless smaller ones; it was clear that at one time the entire plain had been on fire, that a hundred jets of fire and flame and molten lava had spurted from its surface. The heaps were now old and moss-grown, but we were informed of a vague tradition among the people that their ancestors had seen these flames bursting forth. Altogether, in that important journey, we saw and counted a hundred extinct craters, extending over an arc of ninety miles, not reckoning the central mass of Ankàratra, round one side of which that arc bends."[1]

In a journey to the south-east of Madagascar I discovered traces of volcanic action in many places; in some parts shown by the deposits of rolled pebbles of lava, and in others by the streams of lava rock running into the sea and forming reefs which were gradually being broken up by the surf. And in the very opposite part of the island, on the extreme north-west coast opposite the Minnow group of islets, Bishop Kestell-Cornish observes :—"This coast is the most distinctly volcanic that I have seen in Madagascar; at one point the lava must have run down to be quenched in the sea, and it looked as if this had taken place only last year."

In the Antsihànaka province also the same plutonic agency is distinctly visible. A great part of this region consists of an immense marshy plain, about forty miles long by twenty wide, with the lake Alaotra at its north-east corner, and surrounded by hills; and it has evidently been the seat of some powerful subterranean force by which this depression was caused. This is clear from the fact that the lines of hills which are seen on both sides the Antsihànaka plain do not run in the same direction as the main valley or depression of the country, but cut it at an angle of about 45°. Many of the ridges seem to be broken off more or less abruptly by the level ground for several miles, and then are continued on the other side of the plain. It seemed impossible to avoid the conclusion that by some great convulsion a vast rent and depression had been made across the lines of hills in a diagonal direction; while the water-worn remains of some of these toward the south, forming a line of low detached hills, suggested that the action of water, either as an arm of the sea or a great river, had completed what was commenced by more violent agencies. The evidence of former volcanic action in the presence of extinct craters and lava streams to the west, north, and north-east of the plain, gives considerable support to this supposition.

About a hundred miles north of the Antsihànaka province there seem to be further traces of the same agency. The Rev. J. A. Houlder thus describes a remarkable valley called Màndritsàra, which, until he saw it in 1876, was unknown to Europeans even by name, and not marked upon any map:—"It is a great basin, or rather a mighty elongated pit, sunk deep down among the surrounding heights. It is about thirty miles long and

[1] *Proc.* Roy. Geogr. Soc., January 25, 1875, pp. 187, 188.

nearly 2,000 feet below the level of the country east and west of it. Dante would have imagined it, not a 'circle' certainly, but a remnant of some region of the horrible pit itself, which for a wise and gracious purpose had been gently touched by the cooling breath of heaven. There had evidently been a great commotion going on there in the ages gone by; for all the long valley was dotted with rounded hills, giving it the look of boiling water or bubbling pitch, which by some strange process had suddenly become congealed."

It will therefore be seen that igneous agency has been a powerful factor in shaping the physical geography of many portions of Madagascar; in few places could that agency have been present in a grander scale than in the volcanic region of which Madagascar is the centre, and the Comoro and Mascarene groups the extreme points in either direction. An attempt has been made in the accompanying sketch-map to show the prominent features of the physical geography of the island already noted. Probably closer examination would show that the detached groups of extinct craters are all connected by intermediate links, so as to form a continuous line of igneous disturbance from the extreme northern point of Madagascar to at least as far south as the 23rd parallel; and from the appearance of a line of hills seen at a distance south of this latitude, I am strongly inclined to believe that there has been subterranean agency at work even beyond the upper granitic plateaux, but no examination has yet been made of this southernmost region.

With regard to the geology of Madagascar, but little is at present known with any exactness, for no competent geologist has yet made a systematic exploration of the country. There are, however, a few facts of a general character which have been noted by various observers, and these may be here collected together as a slight contribution to a knowledge of this subject pending a more complete and scientific treatment of it.

As already mentioned, the elevated region which forms so large a part of the central, northern, and eastern portions of the island is largely composed of primary and igneous rocks. Granite, gneiss, mica schist, and basalt are present almost all through this high region, and generally form the loftiest points in the country. In a single hill there is often a considerable variety of rock both in colour and texture: granite of various shades of grey, red, and rose-colour, with the constituent parts both fine and coarse. Veins of quartz, running both through these and the clays by which they are overlaid, are often met with, and very fine specimens of rock crystal are frequently found. A hard whitish stone, which has some resemblance to the Yorkshire stone called Bramley Fall, is used in Antanànarìvo for public buildings, as well as for the native tombs.

The lower hills, as well as the high moors, are usually composed of a bright red clay, but below the surface this often seems to pass into a light pink or white earth resembling kaolin or china clay. This frequent change of colour would lead one to infer that atmospheric influences have something to do with the difference between the surface clay and that exposed in the numerous precipitous clefts which the rains excavate on the hill-sides. In many places the material found amongst the rock seems exactly like granite in its constituent parts, but without the cementing elements, so that it can be cut quite easily by a spade. The red clay is sometimes varied by a light brown clay on the hills, while the plains and valleys are filled with rich alluvial clays, blue and black in colour. In all these clays there is an apparently total absence of all organic remains, either animal or vegetable, so that it is not an easy task to determine their geological age, and there is little sign of stratification, although I have detected some appearance of this in the rocks, with tilting of the strata.

In this elevated region there seem to be few, if any, sedimentary rocks of a more recent age than the primary ones which are so prominent a feature of it. A soft dark red stone is found in some places, but this appears to be only a hardened clay. Columnar basalt has been noticed in two or three places, as well as extensive beds of volcanic ash, decomposed lava, scoria, and lava rock of all varieties of hardness, in some of which crystals of olivine are found in abundance.

At one point, however, in the upper region of the island a limestone deposit occurs. This is at Sìrabé, to the south-west of the Ankàratra mountains, and from the pits dug here most of the lime used for building in the central province is procured. It has not yet been examined by any one with competent scientific knowledge, but it appears to be a sulphate of lime, and is probably only a local deposit and not a stratified rock, and most likely is connected with the subterranean action so visible all around the district.

Clay slate is met with in the southern part of this elevated region; and in the Bétsiléo country a valuable slate, suitable both for building and for writing upon, is found, although it has not yet been worked to any extent. According to some accounts, greywacke or whinstone, silex, and chert with chalcedony, are also met with in the southern highlands.

From certain of the facts above given, as well as from other considerations, it appears highly probable that the extensive elevated region of Madagascar is very ancient land, and has most likely remained for many ages above the waters of the Indian Ocean; otherwise, some trace of marine deposits would surely be found in some portion of this great extent of country. I may, however, here note the fact that there are in some places such rounded boulder-like masses of blue basalt rock, sometimes on the surface and sometimes partially embedded in the soil, that did these occur in the temperate zone, one would certainly ascribe them to glacial action; but the point requires fuller investigation, and possibly some other solution may be given to the rather puzzling inquiry suggested. But in travelling to the north-west coast, as we got near the sea-level, we met with boulders composed of rock which certainly is not found *in situ* anywhere near the spot where these boulders occur, but has come from far away in the interior.

With regard to the lower region of Madagascar—the extensive plains to the west and south of the island, as well as the narrower extent of country on the east coast—we have a little more definite information as to the geology of some portions of it. This division of the country is only as many *hundreds* of feet above the sea as the granitic region is *thousands* of feet; and there we find not only deposits of the later Tertiary epochs, containing fossils of animals but recently extinct, but also fossils of the Secondary age. This fact was first pointed out by M. Grandidier, who, in speaking of the south and west portions of the country, says: "*Nerinea* and other characteristic fossils of the Jurassic formation which I have there collected prove the existence of Secondary strata, which cover a vast extent of this island" (*Bull. de la Soc. de Géog.*, août, 1871, p. 88). In a later number of the same publication (avril, 1872) he also speaks of an extensive "terrain nummulitique parfaitement charactérisé par des *Neritina schmideliana*, et pétri de foraminifères appartenant aux genres *Alveolina*, *Orbitoïdes*, *Triloculina*, &c." This is confirmed by the fossils discovered in the south-west of Madagascar, in the upper part of the valley of the St. Augustine river, by the Rev. J. Richardson in 1877. These occur in vast numbers, and from a drawing he gives appear to belong to the Neocomian formation, and are species of the genera *Ammonites*, *Terebratula*, *Nerinea* or *Turritella*, *Einoceramus*, and *Rhynconella*, together with an *Echinoderm*.

It is evident also that there are deposits of a much later date than the above, for in the south-west of Mada-

gascar M. Grandidier discovered the fossil remains of a hippopotamus (a pachyderm not now living in the island), of gigantic tortoises (which are now only found in the little island of Aldebra to the north of Madagascar), and of the probably very recently extinct struthious bird, the *Æpyornis maximus*, whose egg ($12\frac{1}{4}$ in. $\times 9\frac{1}{4}$ in.) so far exceeds that of any other known bird. It seems highly probable, therefore, that a systematic examination of these less elevated portions of Madagascar would reveal the existence of much that is interesting both in palæontology and geology, and so light would be thrown upon many problems connected with the anomalous animal life of the country and of the neighbouring islands in the Indian Ocean. It is evident that these maritime plains were under water during portions at least of the Secondary period, at which epoch the high granitic region alone formed the Island of Madagascar, then a country probably only a third of its present extent.

Dr. Auguste Vinson speaks of seeing yellow sandstone on the eastern coast, and he also describes the plain between the two eastern lines of forest as being composed of beds of sedimentary formations, "rich in fossil remains." Unfortunately he gives no particulars as to these alleged extinct organisms, so we are still in the dark as to the geological age of these formations. In sailing down the river Bétsibòka to the north-west coast, I noticed at one point that for a considerable distance the river bank was formed by layers of yellowish sandstone closely resembling a low wall of masonry. Some of the courses appeared much weathered, while others had a smooth face as if of much harder materials.

From the account given by an intelligent native of some rocks in the western part of Madagascar, and a little to the south of the centre, a conglomerate seems to be found there, for he describes hard rocks of great size as being filled as thickly as possible with rolled pebbles of all dimensions and shapes. He also mentions that near the sea he found a hard black stone which rang like iron, and was full of shells in good preservation and appearance. Unfortunately he too brought no specimens for examination.

A little more information as to the geology of Madagascar is found in papers contributed to scientific periodicals in England and France several years ago. The earliest of these is by the late Dr. Buckland, who, in a "Notice on the Geological Structure of a Part of the Island of Madagascar" [1] (Port Louquez, near the northern extremity), describes a sandstone without fossils, which he compares to the New Red Sandstone, and in which are intercalated trap-rocks similar to those of Antrim in Ireland.

As to the north-west side of Madagascar, in the *Annales des Mines* (1854, 5me série, t. vi. pp. 570-576) there is a paper on the discovery of beds of lignite both in the island of Nòsibé and at two points on the north-west coast. In the opinion of the officers who made the exploration the beds of this combustible are more ancient than the Tertiary formation. It is contained in layers of sandstone and clay schists, is fibrous, and shining, and burns readily with a long and white flame, leaving little ash. If beds of this lignite should be discovered in greater thickness it will therefore be valuable both as steam coal and for use in the industrial arts.

In the same French publication of a little later date (5me série, t. viii., 1856) there is an "Essai sur la Géologie de Nòsibé," in which the soil of that island is described as consisting of three different groups of strata:—(1) granitic rock, gneiss, mica-schist, slaty-schist, and plastic clay; (2) red and yellow sandstones, traversed by veins of gneiss and quartz; while (3) is essentially volcanic, consisting of basaltic and trap lavas, overlaid in some places by beds of sandy material, tuffs, and volcanic *rappilis*. The essay is accompanied by a complete geological map.

[1] *Trans.* Geol. Soc. London, vol. v. p. 478.

Since the date of this last paper some further attention has been paid to this part of the country in connection with the French Company proposed by M. Lambert,[1] but hardly anything more has been done towards a scientific examination of other portions of Madagascar except a slight notice of the peninsula inclosing Antongil Bay,[2] although probably M. Grandidier will have some fresh information in his great work now in progress.

It may be here observed that a reef barrier of coral extends for at least 350 miles along the east coast, varying in its distance from the land from a quarter of a mile to three or four miles; while fringing reefs surround the northern end of the island, extending for 400 miles down its eastern side, and are also found on the south-west coast.

With regard to minerals, Madagascar is tolerably rich in some of the most useful metals. Iron is found in great abundance in Imérina, sometimes almost in a pure state. In some of the hills it is so plentiful that it is difficult to get a bearing with the compass, from the deflection caused by the iron in the ground. Copper, lead, and silver have also been discovered, and from the geological structure of the country it is highly probable that gold would be found in some of the ravines of the granitic highlands; but as it is at present a serious offence against the native laws to search for the precious metals, hardly anything has been done in this direction. Rock-salt is found near the coast, and nitre is also met with. Iron pyrites, from which sulphur is extracted, is also found in abundance; in the northern part of the island antimony seems to be plentiful, and oxide of manganese has been found about fifty miles south of the capital. A substance resembling plumbago exists in great abundance, and is used by the Malagasy to colour and glaze some of their articles of pottery. A considerable variety of ochres and coloured earths are met with, and are used not only for colouring the native houses, but also in dyeing some of the woven cloths made by the people.

In conclusion, it may be remarked that there is a vast extent of country on the coast-plains where the soil is most fertile, but which is only thinly peopled, or has no population at all. Many parts of the island which separate the territory of one tribe from another are well watered and wooded, and seem to invite occupation. Madagascar could well sustain a population from ten to twenty times its present amount, for hardly any portion of it is rainless or desert, except a small section of the extreme south-western coast. Surrounded by the ocean it enjoys an abundant rainfall, so that the droughts which constantly afflict large portions of Southern Africa never occur in Madagascar, while its insular position gives it a more equable climate, freer from extremes of temperature, than is enjoyed in most tropical countries.

JAMES SIBREE, Jun.

NOTES

THE first zoological station established in Scotland was opened the other day at Cowie, near Stonehaven. The work, which is more directly in connection with the natural history class of the Aberdeen University, will be carried on in a small wooden house which was erected in the beginning of last week on flat ground, a few yards to the north of Cowie, and close to the sea-shore. The building was constructed in sections, special provision being made for ventilation. It consists of two apartments, the lesser of which is to be fitted up as a library and office, while the main room will be devoted to reception of the proceeds of the dredging, trawling, and other expeditions. The latter department contains the dredging and trawling apparatus, a number of microscopes, with chemical and other appliances

[1] See *Annales des Mines*, 6me série, t. x. pp. 277-319.
[2] *Bull. de la Soc. de Géog.*, Sept. et Oct., 1867.

necessary. Two boats are at the disposal of students—a large yawl and a small boat, kindly lent by Major Innes of Raenoir, who has also given the use of his drill-hall as a store. A select party assembled at luncheon, after which Mr. G. J. Romanes, in a brief and happy address, formally declared the station open. The total sum now raised is 350*l.*, but this is not enough, and we regret that the appeal made through our columns and elsewhere, has not been so successful as it should have been. This, we believe, is more due to want of thought than illiberality, and we trust that the work at this the first genuine zoological station in the kingdom, will not be crippled from want of sufficient funds. Mr. Romanes will be happy to receive further subscriptions.

ON Friday, in the House of Commons, Mr. Shaw-Lefevre asked what arrangements had been made as to the management of the Natural History Collection about to be removed to South Kensington? He hoped that advantage would be taken of this opportunity to make some change, so that the management of that collection might be entirely different from the management of the other collections of the museum. In reply, Mr. Walpole said that the recommendations made by the Royal Commission were communicated to the Treasury in February last, and were then transmitted to the trustees of the museum. The trustees had carefully considered those recommendations and had sent in a scheme to the Treasury, and the matter was now in the Treasury's hands. The views of those who took a particular interest in scientific matters and in the advancement of science had been taken into consideration, and he thought he might say the future management of the museum would give complete satisfaction, not only to them, but to the public generally.

DR. J. FR. BRANDT, the veteran Russian naturalist of St. Petersburg, whose works were referred to in last week's Notes, died on the 7th ult., at the age of seventy-seven. Dr. Brandt has been for many years director of the Imperial Museum of Zoology in the Russian capital, and is author of many important memoirs in the *Transactions* of the Imperial Academy of Sciences of St. Petersburg.

THE *Times* announces the death of Prof. Lamont, a Scotchman by birth, and director of the Munich Observatory. Prof. Lamont, who was seventy-four years of age, and had been employed at the Munich Observatory since 1835, may almost be called the father of modern terrestrial magnetism.

THE death is announced of Herr Joseph Haardt von Hartenthurm, one of the most eminent of German cartographers. He died at Vienna on July 28, at the early age of thirty-nine.

THE proceedings of the first Austrian Anthropological meeting began on July 28, the assembly being exceedingly numerous. Prof. von Hochstetter was the president, and spoke on ambulant meetings for the purpose of common work. Herr Deschmann, of Laibach, read a paper on the latest discoveries in the heathen hill tombs of St. Margarethen. Prof. Gurlitt, of Graz, spoke on clay vases, and Prof. Alfons Müllner on the method of beginning practical work in anthropology. A paper was then read on local geographical and personal names in Carniola, by Dr. Arnold von Luschin. On the 29th Count Wurmbrand and Herr Szombathy delivered lectures on skull measuring and investigations relating to the colours of hair, skin, and eyes. Herr Scheyer spoke on ancient sepulchres, and Herr Obermüller on prehistoric times. In the afternoon the meeting visited the lake-dwellings in the Moorgrund.

AT the celebration of the 100th anniversary of the foundation of the "Naturforschende Gesellschaft" at Halle on July 30 last, Prof. Knoblauch welcomed the guests in an able address. Afterwards the secretary of the Society, Dr. Marchand, gave a historical retrospect of the Society's activity, and then followed a "festival" address by Prof. Kraus and the reading of a letter from Dr. Naegeli, of Munich.

A MODEL of Mr. George Fawcus's gun-carriage slide (referred to in NATURE, vol. xx. p. 337) may be seen at the Royal United Service Institution.

THE *Tokio Times* of May 10 reports a meeting of the Biological Society of the Tokio dai Gaku, on Sunday, May 4. Prof. Yatabe made a communication on the flora of the Bonin Islands. He showed how seeds could be transported thither by means of currents, and called attention to the various currents affecting the fauna and flora of the dependency. He then described the general character of the flora, and pointed out the differences between the plants of the islands and Japan proper. He also called attention to the similarities existing between those of the Bonins and Southern China and India. Mr. I. Iijima communicated some facts regarding the habits of a species of pteropus, a large winged bat from the Bonin Islands, a living male specimen of which was exhibited to the Society. After briefly stating its relations to the mammals, and that the individuals of this group were frugivorous, he stated that there were about forty species known, distributed among the islands of the Pacific. The Bonin Island pteropus subsists chiefly on the banana, frequenting the trees during the daytime, and at night flitting in the air in considerable numbers. The features closely resemble those of the fox, and hence the name of flying-fox generally given them. The fur is long and black, with white hairs intermixed. A few hairs taken from the specimen and others from a Sumatra species were shown under the microscope, and their peculiarities explained. The pteropus constantly hangs from the roost head downward; and when about to sleep hangs by one leg, spreads its wings, and then wraps them closely about the breast, hiding its head beneath the membranous folds. The specimen had been fed almost exclusively on sweet potato, though it would eat boiled peas and rice, and orange if it was juicy. If a big piece of sweet potato is given it, the fragment is grasped by one of the hind legs, and not having an opposable thumb, it is held firmly against the breast. Reaching up the head, the bat tears away a large mouthful and then chews it a long time, making a smacking sound in the act, and at each movement of the jaws thrusts out its lanceolate tongue. The fibre of the potato and pulp of the fruit is invariably ejected from the mouth, and just before doing this, one or two vigorous sucks are heard, as if the animal was drawing out the remaining juice. This performance is accompanied by a singular jerk of the head. In the act of chewing, the morsel is changed from one side of the mouth to the other. When its appetite is fully satisfied it begins to scratch its body with its hind leg. The long tongue also comes into service to cleanse the fur. It is a curious sight to see the long nail on the thumb used as a toothpick. The toes are also employed for a similar purpose. Prof. Yatabe remarked that the banana was not indigenous to the Bonins, but had been introduced, and the pteropus had acquired a taste for it.

ARAGO having been born at Estagel, a small country place in the department of the Pyrenées Orientales, the citizens of Perpignan, the head town of this district, have decided to erect a statue to him by public subscription. The inauguration will take place on September 21 next, and will be celebrated by a three days' *fête*. We are informed that an address will be delivered by M. Paul Bert, the physiologist, and influential member of the Chamber of Deputies. It is strange that no astronomer or physicist has been selected for this great occasion.

THE French Parliament voted before the vacation a law obliging landed proprietors to protect their vines against the invasion of the Phylloxera. The *Journal Officiel* publishes a report signed by M. Teissoniere, member of the Council of the Society

of French Agriculturists, and vice-president of the Chamber of Commerce of Paris, showing the efficacy of sulpho-carbonate for destroying that pest. The experiment was made on 464,557 plants, covering a surface of 110 hectares, or 272 acres. A quantity of about 35 tons of sulpho-carbonate was employed with 10,000 cubic metres of water. The total expense was about 4*l.* per acre. This sum will be reduced very shortly in a large proportion by a diminution of the sulpho-carbonate, which actually costs 2*l.* per cwt., and will be sold at 1*l.* when the method has been adopted on a large scale. The plants were unhurt, and the vegetation was found to be luxuriant. Insects injurious to grapes were destroyed at the same time.

ON the occasion of the inauguration of M. Thiers' statue an aëronautical ascent was made at Nancy on August 4. The wind was blowing from the west with a velocity of 16½ kilometres an hour, and no variation in the direction was perceptible from the ground to 800 metres. The altitude of the balloon was taken by officers from Mazléville, with a theodolite, and signals were exchanged with the ground during the ascent. The signals were given by the aëronauts with a flag, and by officers with a reflecting mirror placed in the end of a tube, and mounted as a telescope. The officers directed the rays of the sun on the balloon, and intercepted rays with a key in order to use the Morse alphabet. The distance of Mazléville from the balloon was more than six kilometres, and the signals could be seen at a much greater distance. This shows that in a besieged town a passing balloon could be used for giving orders to, or receiving news from friendly forces. The system of communication has been invented by one of the officers of the garrison. M. W. de Fonvielle was in the car.

IN 1789 the Royal Library of Paris contained 800,000 volumes and objects of every description. In 1859 the number averaged 1,200,000. During the last twenty years the increase has been more sensible, and the actual number is estimated at 2,000,000. The mean annual increase from legal deposits alone is 20,000. Out of these 2,000,000 about 450,000 are devoted to French history, 200,000 to theology, 90,000 to science and philosophy, 60,000 to natural history, and 120,000 to English history. The greater part of French and English historical and medical works are arranged in printed systematic catalogues placed in the hands of the public. In less than ten years the whole of the catalogues will be printed.

THE Trustees of the South African Museum at Cape Town issue a very satisfactory report for 1878. Several important improvements have been made in the building, valuable additions, especially of insects, have been made, and the collection has been inspected by a large number of South African and foreign naturalists.

A BRIGHT meteor was observed in many places in Saxony and the adjacent Voigtland, during the night of July 26–27. An observer at Droeda (a village in the south-west corner of the kingdom) reports: "At 12.45 the nocturnal darkness was suddenly interrupted by an illumination of the whole firmament, which nearly reached daylight in intensity, and which lasted for three seconds. A beautifully bright blue fire-ball was slowly moving in the heavens from south to north. At Plauen the fall of the meteor was observed, and at Greiz even two fire-balls were seen." Corresponding news reaches us from Leipzig, Dresden, Zwickau, Wiedersberg, &c.

MR. MORRIS's report on the Ceylon coffee-leaf disease, to which we have before referred, urges the necessity of uprooting trees which are very seriously affected, and of treating the remainder with a compound of sulphur and lime. Grass, it is urged, should not be left near the trees, and all diseased leaves should be burnt. Before leaving Ceylon for Jamaica, Mr. Morris was to deliver an address to the Chamber of Commerce on the all-important subject.

THE *Times* Berlin correspondent states that Dr. Schliemann, after having spent a month's holiday at Kissingen, has gone to pass a few days at his home in Mecklenburg, after which he will proceed to London to superintend the publication of his new work on Troy, embodying all his most recent researches, to which Prof. Virchow will contribute the preface.

AN extremely satisfactory report for 1878 is issued by the Manchester Scientific Students' Association. It contains several interesting papers, including a short presidential address by Prof. Williamson, and instructive accounts of the numerous excursions of the Society. A satisfactory report for 1878-9 has also been issued by the Leicester Literary and Philosophical Society, and we are glad to see, from the seventh report of the Leicester Town Museum, that that institute is steadily improving. Mr. Octavius Stone's New Guinea Birds are being arranged in their new cases by Mr. Montague Brown, and will shortly be ready for exhibition.

THE Peking correspondent of the *North China Herald* states that a college will shortly be opened there for the training of young diplomats, and it is understood that it will be under the direction of a former professor in the Tungwên College, aided by competent assistants.

SOME time ago the *Japan Gazette* stated that the Government were engaged in surveying a line of railway from the coal mines at Horouchi, in the island of Yezo, to Koishigari, a town on the chief branch of the River Ishigari. The survey has now been completed, but the original plan has been altered materially. It appears that the country for some distance along the proposed route is low and subject to occasional inundations from the overflowing of the river. One of these recently occurred, and showed the difficulties of the proposed route. It has, therefore, been determined to make a shorter line to the village of Horouchi, on another branch of the Ishigari, which is navigable for flat-bottomed vessels. The specimens taken from these coal-mines to Yedo are said to be very fine, and as the mines are to be worked on the most approved system, they are expected to prove a great national benefit.

SOME valuable kerosene springs are stated to have been discovered in Uzen and Ugo, two Japanese provinces lying to the north of Yedo.

A JAPAN paper states that the new arsenal and dockyard to be founded at Mihara for the Japanese navy will be very complete and magnificent. Dry and wet docks are to be constructed fit for the largest war-ships; and there will be iron sheds, in which ironclads and wooden war-vessels may be built without hindrance from the weather, as well as foundries, engine-shops, rolling mills, stores, &c. The expense of these works, it is expected, will be enormous, especially as there are also to be barracks and fortifications for their protection.

THE additions to the Zoological Society's Gardens during the past week include a Rude Fox (*Canis rudis*) from Demerara, presented by Mr. G. H. Hawtayne, C.M.Z.S.; a Grey Flying Squirrel (*Sciuropterus fimbriatus*) from North India, presented by Mrs. Louisa Edwards; a White-whiskered Swine (*Sus leucomystax*) from China, presented by Mr. Theodore Hance, C.M.Z.S.; a Black-faced Ibis (*Geronticus melanopis*) from Chili, presented by Mr. C. H. Whaley; three North American Turkeys (*Meleagris gallopavo*) from North America, presented by Mr. R. Wynne Roberts; three Common Kestrels (*Tinnunculus alaudarius*), European, presented by the Rev. J. E. Campbell Colquhoun; two Vociferous Sea Eagles (*Haliaëtus vocifer*) from East Africa, presented by Dr. J. Kirk, C.M.Z.S.;

a Lanner Falcon (*Falco lanarius*), East European, presented by Lord Lilford, F.Z.S.; a Wood Owl (*Syrnium aluco*), European, presented by Capt. F. Lloyd; two Vulturine Guinea Fowls (*Numida vulturina*), four Elliot's Guinea Fowls (*Numida ellioti*), three Mitred Guinea Fowls (*Numida mitrata*) from East Africa, deposited; a Pileated Jay (*Cyanocorax pileata*) from South America, two Black Storks (*Ciconia nigra*), European, purchased; a Red-fronted Lemur (*Lemur rufifrons*) from Madagascar, a Tamandua Ant-eater (*Tamandua tetradactyla*) from South America, a Black Hornbill (*Buceros atratus*) from West Africa, four Specious Pigeons (*Columba speciosa*), a Banded Tinamou (*Crypturus noctivagus*) from South America, received in exchange; an Amherst Pheasant (*Thaumalea amherstiæ*), three Fork-tailed Jungle Fowls (*Gallus furcatus*), three Chilian Pintails (*Dafila spinicauda*), seven Brazilian Teal (*Querquedula brasiliensis*), an Australian Wild Duck (*Anas superciliosa*), bred in the Gardens.

ON SPHENOPHYLLUM, ASTEROPHYLLITES, AND CALAMITES[1]

I HAVE just received from Herr D. Stur an abstract of a memoir in which he announces that he has obtained a specimen from the Carboniferous rocks in which he finds twigs of Asterophyllites and Sphenophyllum, forming the branches of the stem of a Calamite, and that the strobili of Bruckmanniæ occur at the ends of such of the branches as support Sphenophylloid leaves. Herr D. Stur appears to regard Sphenophyllum as representing the foliage of the fruiting twigs of the plant, whilst Asterophyllites represents the ordinary vegetative foliage of the same plant.

That this should be true, so far as regards the unity of Asterophyllites and Sphenophyllum is concerned, appears to me to be most probable. As you are aware, I carefully investigated this subject in Part V. of my series of memoirs "On the Organisation of the Fossil Plants of the Coal-Measures." Accepting the conclusions of M. Renault, published in some of his valuable memoirs on the St. Etienne plants, as conclusive so far as Sphenophyllum is concerned, I showed that plants which are undoubtedly examples of Asterophyllites have stems the internal structure of which is identical with that of M. Renault's Sphenophyllums. These facts led me to the inevitable conclusion that the two genera were very closely allied to one another. In my Memoir, Part IX., I described an additional specimen (Fig. 32), which gave further support to my previously expressed opinion, and the further investigations which I then conducted led me unhesitatingly to affirm "that Asterophyllites and Sphenophyllum are genera so closely allied, *that their separate existence finds but little justification in nature*" (*loc. cit.*, p. 334). In fact, it has long appeared to me that, morphologically, the leaflet of Spenophyllum was merely the resultant of the coalescence of two or three leaflets of Asterophyllites.

Herr D. Stur's discovery appears to afford an unanswerable confirmation of these views. His further discovery of Volkmanniæ[2] connected with his plant, which combines Sphenophyllum with Asterophyllites, further sustains a conclusion which I have arrived at in my memoir, Part V., pp. 55–56, viz., "that *Calamostachys* (Volkmannia) *binneyana* has much closer affinities with Asterophyllites than with Calamites" (*loc. cit.*, p. 65).

But Herr Stur further states that the stem from which these Asterophyllitean and Sphenophylloid twigs spring is a Calamites which he names *Calamites sachsii*. Not being acquainted with the plant to which he gives this name, I can form no opinion as to its nature; but I must confess I find it impossible to believe that it can be a Calamite of the common and only type which we find in England. Both my memoirs, Part I. and Part IX., contain a series of illustrations of the structure of our English Calamites, from that of stems that must have been nearly half a metre in diameter down to twigs having only a diameter of ·000837 of a metre, which latter specimens are, I presume, the most minute examples that have been recorded by any observer. Yet all these graduated Calamites have exactly the same typical structure; they possess an ample medulla, which becomes fistular at an early age; this is surrounded by a circle of longitudinal canals, which run from node to node. External to each canal we find a corresponding wedge-shaped mass of radiating vascular laminæ. These wedges are widely separated, in young plants and branches, by large, radial prolongations of the pith—the primary medullary rays of my memoirs—but in older branches these rays diminish in size, so that the wedges become blended together at their broad subcortical portions. These Zylem structures are enclosed within a true Phloem, which is uniformly parenchymatous in its young state, but which becomes differentiated into two or more layers, as the plant grows older; the chief of these layers, so far as size is concerned, being a thick mass of prosenchyma. Now the internal structure of Asterophyllites and Sphenophyllum differs from that of Calamites *in every one of these features*. The youngest twigs, as well as the larger branches of these two genera, are equally devoid of a medulla. The place occupied by that cellular tissue in the *young* Calamite is filled, in equally young twigs of Asterophyllites and Sphenophyllum by an *exclusively vascular* bundle, transverse sections of which exhibit the form of a remarkable triangle with three very concave sides. There are no inter-nodal canals, and the vascular zone, which is largely developed externally to the primary triangular vascular bundle by an exogenous process of growth, is *not* divided into separate wedges by large primary medullary rays. In Calamites each vascular wedge is subdivided into laminæ by numerous, perfectly developed, secondary medullary rays. In Asterophyllites and Sphenophyllum, these rays are of the most rudimentary character, though they exist, as my friend M. Renault has shown, in the shape of groups of cells distributed through the vascular zone.[1]

The bark of the two genera in question is as distinct from that of Calamites as are the medullary and Zylem portions of the respective stems. It consists of two layers which have no counterparts in the Phloem of Calamites. In addition to these details, there is a general triquetrous arrangement in the organisation of Asterophyllites and Sphenophyllum, which has no existence in Calamites. The foliar vascular bundles of the former are only given off from the apex of each of the three prolonged angles of the central triangular bundle of the young twig, whilst no one of the wedges forming the regular Zylem-cylinder of the Calamite has any predominance over the rest.

Such extreme and fundamental differences as these, affecting, as they do, the structure of every layer of tissue from the centre to the periphery of the axis, and at every stage of its growth, make it absolutely impossible that Asterophyllites and Sphenophyllum can be associated with any of the Calamites that are so abundant in our English coal-measures, and with the organisation of which we are now so perfectly acquainted.

That the stem so long, but so improperly, associated with the genus Calamites, viz., the *Calamites verticillatus* of Lindley and Hutton may have been the arborescent stem of these Sphenophylloid plants is as I have shown in my Memoir, Part V., extremely probable. But, I repeat, this stem has no claim whatever to be included amongst the true Calamites.

Such being the conclusions at which I have arrived from the careful study of the inner structure of an enormous number of stems of Calamites and Asterophyllites, and from a comparison of these latter with the facts published in the valuable Memoirs of M. Renault on Sphenophyllum, I shall look forward with great interest to the results of a critical examination of the stem which our fellow-labourer at Vienna has discovered.

W. C. WILLIAMSON

[1] This brief contribution was originally a letter to Prof. Weiss, of Berlin, but it was kindly translated by him, and published in the *Neuen Jahrbuch für Mineralogie, Geologie und Paläontologie*, Jahrgang, 1872, as a communication, with the title of "Sphenophyllum, Asterophyllites, und Calamites, deren Stellung zu einander nach den letzten Beobachtungen." It is only republished now as being necessary to the understanding of Prof. Weiss's interesting communication, which he published along with mine, and which it appears to me desirable to republish for the benefit of English palæo-botanists. I am indebted to my friend Mr. Hartog for its translation into English.

[2] Herr Stur's Bruckmanniæ appear to be that form of spike long designated Volkmanniæ, but now separated as Calamostachys, and of which the *Calamostachys binneyana* is the only British example with the internal organisation of which we are acquainted.

[1] So imperfect is the organisation of these medullary rays, that M. Renault is not prepared to recognise their claim to the title, a point on which I am obliged to differ from him.

Further Remarks to the Preceding Treatise, by E. Weiss, Berlin

Stur's remarkable paper, to which the above communication of Prof. Williamson, the esteemed investigator of Manchester, refers, is the description of a slab on which several branches of Asterophyllites give off, at certain points, lateral twigs with the foliage of *Sphenophyllum dichotomum*, some of which bear terminal spikes of Volkmannia, Stur; at other points he finds

the same Asterophyllites bearing spikes of the type Bruckmannia, Stur, and in such relations that it can only be the offset from a Calamites found lying with it, of which no definition is given, but which has previously been designated *C. sachsii*, Stur. From this Stur draws the following conclusions:—1. Sphenophyllum is a branch of Asterophyllites. (2) Both Sphenophyllum and Asterophyllites are branches of a Calamites. (3) Sphenophyllum is not a distinct botanical genus, but the Macrosporophorous branch of an Asterophyllites—that is of a Calamites. This, if correct, would be one of the most remarkable results in Palæophytology. A Calamites bearing not only twigs, ascribed hitherto to different genera, but to such different fructifications! and besides, we have the incompatibility in the anatomical structure of the stems of Calamites and Sphenophyllum, to which Williamson's remarks are directed. It is not every one that can step so lightly over these difficulties in order to unite the three genera into one. Some grounds, one would think, are still left, not only to indicate, but to compel the separation of these genera, and even to warrant their location in different families, and to call for caution in the interpretation of such facts as the above. To estimate the importance of these facts, we will call attention to the present state of the question.

The widespread genus Calamites, whose structure has been elucidated by Williamson and others, is now almost universally associated with Equisetum in the group Calamariæ, while, as is known, Sphenophyllum has been repeatedly classed with Lycopodiaceæ within the last few years. Williamson insists on the anatomical incompatibility between Calamites and Sphenophyllum (with which he includes Asterophyllites) as brought out by his own microscopical researches; and indeed all previous investigations in botany would protest against the insertion of twigs with the structure of Sphenophyllum on stems or branches, with the structure of Calamites. They possess, in common, only the external characters of the transverse segmentation of the stem, and the conformity of the separate internodes; but this conformity of segmentation is the chief ground for Stur's view, that all such genera as Annularia, Asterophyllites, and now also Sphenophyllum, pass into Calamites. Many stems, such as that bearing *Stachannularia tuberculata* (see my Carboniferous Calamites in *Abhandl. zür geolog. Specialkarte von Preussen*, Band ii. Heft i., Taf. ii. Fig. 1), are Calamites in his eyes, which others do not recognise as such, and he will not allow of any [systematic] severance of a section of the Calamarioid stems from Calamites proper. Hence it is that from Calamites, Stur, most divers things ramify.

In the second point of importance, however, the close conformity of Asterophyllites and Sphenophyllum, Williamson agrees with Stur. According to him, either the two genera have altogether the same anatomical structure, or, at least, there are plants resembling the former having the stem-structure of the latter. Renault, on the contrary, is convinced that some of Williamson's preparations really belong to Sphenophyllum, agreeing with the fragments from Autun and St. Etienne investigated by himself.[1] The twigs which show Calamite structure are referred by Williamson to Calamites, and appear to be those which, without a knowledge of their internal structure, would be placed in Asterophyllites. These would come under Calamocladus of Schimper, whilst Williamson's Asterophyllites appear to be next related to Sphenophyllum.

These two forms agree so closely in the external characters of their sterile parts as to be undistinguishable without microscopic investigation; so that one is inclined to leave them together under the old provisional generic name of Asterophyllites, despite their probable essential difference. That section of Asterophyllites which shows the same stem-structure as Sphenophyllum may be allowed to be closely allied thereto, and, in some cases, even to belong to the same individual as Stur's discovery would indicate. It is possible that in well preserved fossils we may still find some single [external] character, which will distinguish this section of Asterophyllites from those which approach Calamites. It would lie in the decided trimery of the leaves in the verticils of the former (when regularly developed), corresponding with the triangular bundle of the axis, from the angles of which the vessels of the leaf spring. The difference of leaf-form as an absolute character separating Asterophyllites and Sphenophyllum must now be given up.

From the botanist's point of view there is another very important ordinal or generic distinction, to be found in the fructification. Every one must be astonished at Stur's pointing out both Bruckmannia and Volkmannia spikes on his plant. By the former he means Calamarioid spikes with sporangiophores and sporangia between pairs of approximated verticils of Bracts (Calamostachys, Auct.). By the latter, spikes with sporangiophores and the sporangia axillary (Palæostachya, Weiss.) Whether these two arrangements are really present here is not yet clearly shown; at least, in answer to my inquiries, Stur gives no definite information on that point, but refers to the forthcoming fuller memoir which he promises. Hence it is still an open question whether the arrangement is not that hitherto alone recognised as that of Sphenophyllum—that is, sporangia without sporangiophores, sessile in or near the axils of the leaves. This mode of attachment may certainly also be concluded from Renault's last excellent communication ("Nouvelles Recherches sur la Structure des Sphenophyllum," *Ann. d. Sc. Nat. Bot.*, 1877). My own observations on a beautiful spike from Wettin, give the same result.

But it must also be borne in mind that those spikes to which I have thought right to restrict the name Volkmannia, which in all probability belong to twigs with the foliage of Asterophyllites, have the same sessile, axillary sporangia, so far as can be determined. If this be correct, however, there can be no difficulty from this point of view in uniting these Volkmanniæ (not Sturs, which belong to Palæostachya) with the spikes of Sphenophyllum into a single group. This is a further corroboration of my formerly expressed conclusion, that the two form a group which must be removed from the Calamariæ.

On summing up the results of these critical comparisons, we find (what has not yet been thoroughly contradicted) that Sphenophyllum may be grouped under Lycopodiaceæ, anatomical structure and fructification alike removing it from Calamariæ. Only it becomes more and more impossible to dispute that the convenient generic names Calamites, Asterophyllites, &c., are purely provisional—unfitted, it is true, to show the real relations of the plants that bear them, but indispensable, in the great majority of cases, where the material is insufficient for complete investigation, important though it be. Plants with stems and leaves of undistinguishable appearance, especially in the ordinary state of preservation, but with such different fructifications as Calamostachys and Palæostachya, for instance, must retain their autonomy, and Sphenophyllum still more so. It is not every arborescent Calamarioid stem, not every so-called Calamites that belongs to this botanical genus. It has now become very evident that what has been hitherto termed Asterophyllites, comprises plants of several groups; yet Cingularia and Bowmannites had already been distinguished, though they both possessed the stem of Asterophyllites, as regards external structure and foliation. We see that the practical difficulties in the distinction and nomenclature of fossils are augmented; but this lies in the very nature of the case. It is thus unnecessary to doubt the co-existence of Asterophyllites and Sphenophyllum twigs on one plant, as Stur has observed, without going on to admit his conclusions that Asterophyllites, as a whole, is identical with Sphenophyllum, and that both are Calamites. If the spikes cited are really Calamostachys (Bruckmannia, Stur) and Palæostachya (Volkmannia, Stur), this would show the distinctness of the fossils regarded by him as identical. Renault has found both macrosporangia and microsporangia on the same spike of Sphenophyllum; this tells against the view that Volkmannia, Stur (that is, in this case, the Sphenophyllum spike) is the female, and Bruckmannia, Stur, the male fruiting spike of one and the same plant. It will be seen how desirable it is to have further cautious investigation and careful publication upon the interesting find on which we are to base such far-reaching conclusions as those which Stur has lately drawn.

[1] On this point M. Renault is mistaken; they differ in the chief features which distinguish Sphenophyllum from Asterophyllites, viz., in the number and shape of the leaves and in the number of the separate vascular bundles given off to these leaves.—W. C. W.

ANTHROPOLOGICAL INQUIRY IN FRANCE

THE published reports of the proceedings of the Société d'Anthropologie of Paris, for the year ending in the autumn of 1878, testify as usual to the diligence and zeal of a large number of its members. Limiting ourselves to the notice of papers which deal with questions of French local palæontology and sociology, we will begin our *résumé* by drawing attention to the interesting labours of M. Prunières, who has laid before the Society the result of several years' exploration of the Beaumes-Chaudes caverns in Lozère, the largest prehistoric ossuary yet brought to light. Here he recovered the remains of

300 individuals, besides a mass of more than 200,000 fragmentary pieces. These human bones were white, showing no trace of the action of fire, although charred animal bones and broken pottery were found near them, the whole being embedded in stalagmite and stalactite as hard as marble. The dolichocephalic crania, protruding jaws, and flat tibiæ, showed a close affinity to the Cro-Magnon and l'Homme-mort remains; and M. Prunières is of opinion, that at Beaumes-Chaudes we have evidence of the existence of a race differing essentially from those which have occupied France in modern times, and even from the pre-historic men of the neighbouring dolmens of Lozère. In the latter, and in the dolmen founders of western France generally, he recognises the more civilised agricultural race which waged war against the ruder cave-men, and finally exterminated them. And he believes we have indisputable evidence of this conflict of races in the fact, that while several of the Beaumes-Chaudes bones were found to have slender flints impacted in them of the kind discovered in the dolmens, and differing wholly from the flint arrow heads characteristic of the cave-men, only a few of the same form of silex were found lying loose in the *débris*, and these he thinks we may fairly assume to have become detached in the process of decomposition from the softer tissues of the body, in which they had been arrested. Some of the crania exhibited a hitherto unnoticed form of double-trepanning of the right and left parietals, whose different cicatrices appeared to show that a considerable interval had elapsed between the first and second operation, which probably was the pre-historic surgical remedy for convulsions, and all affections included in later ages under the term "possession."

At Cravanche, near Belfort, a somewhat similar mortuary cavern has been examined by M. Bernard. Here the seven nearly perfect crania, extricated from an enormous mass of human bones, were all remarkable for their large cubic capacity (1680 centims.), the vertical index being 70, and the cephalic index 72. No iron or bronze implements were found, but numerous flints and serpentine rings were obtained. M. Leguay has done much to settle the question of the implements with which pre-historic men cut and carved schist and bone objects, by his successful imitation of a schist amulet, found by M. Rivière 24 feet below the floor of the Mentone caverns. In the fabrication of this spurious antique, M. Leguay used some of the flint knives so common in pre-historic caverns, which are blunt at the extremity, and curved towards the middle; with these he was able after a little practice to effect all the graving and cutting required to produce exact facsimiles of the pre-historic originals, and he believes, that wherever we find an excessive accumulation of flint-splints and fragments we have evidence of being on the site of a work-place or factory, rather than that of an ordinary primæval dwelling. It should be observed that M. Broca has used a cave-silex in trepanning a dog, which recovered with less than ordinary inconvenience from the operation. The neighbourhood of Luchon in the French Pyrenees has long been recognised by geologists as an admirable locality for the study of glacial action, evidences of which abound in the moraines and huge erratic boulders which cover the southern flank of Mont Espiaup, and block up the valley of the Oô; but it is only within the last few years that French archæologists have directed their attention to the innumerable megalithic remains which occur in the district, and which, as in other parts of the Pyrenean range, still maintain some of their ancient sanctity in the eyes of the peasantry. These remains have now been carefully studied by MM. Piette and Sacaze, the results of whose most important investigations were given in detail in a paper printed in *Bulletin d'Anthropologie*, tome 12, série 2, 1877. From these and subsequent researches, it would appear that the megalithic circles and rows have generally been made to follow the direction of the granite boulders, smaller stones having been used to complete the desired outlines. Under the cromlechs and within the stone circles numerous urns were found, containing for the most part only ashes; but in one instance, two bronze armlets, nearly identical with those of the Swiss lake dwellings, were discovered. Local tradition and still existing practices warrant the assumption that the so-called fire-stones—menhirs—were long associated with fire-worship; while the form of certain stones, which in defiance of the clergy continue to be made the centres of various local games and dances, together with the character of the mysterious and hidden ceremonials which are practised in relation to them, as clearly point to a not wholly eradicated observance of phallic rites. Near Maintenon, M. Lamy has succeeded in proving the existence of menhirs and dolmens, and has opened a burial chamber in which, besides two adults, he found a child's skeleton standing upright in the grave.

The attention of several members of the Society has been directed to the improvement of instruments for the attainment of reliable craniometrical determinations; and among these the double graduated square, invented and used by Dr. Harmand during his extensive travels in India and China, and the portable cephalometer, specially designed by Dr. Le Bon for the correct measurement of the vertical height of the head, appear to have met with the greatest approval. The former is described at length in the tome 12, sér. 2 (1877), and the latter in tome 1, sér. 3 (1878) of the *Bulletin d'Anthropologie*. M. Broca has drawn attention to the injurious action of alcohol on the preservation of crania, and recommends the use of nitric acid, followed by immersion in glycerine before the varnish is applied. M. Personne on the other hand prefers the use of chloral, under the action of which he has found that the cranial bones contract, and become as hard as wood. Much interest has been excited in the Society by the report of M. Thulié, on the appearance of the brain of M. Asseline, one of its members who had belonged, like many of his anthropological confrères, to the Société d'Autopsie mutuelle. M. Asseline died in 1878, at the age of 49. He was a republican and a materialist; was possessed of enormous capacity for work, great faculty of mental assimilation, and an extraordinarily retentive memory; and had a gentle benevolent disposition, keen susceptibilities, refined taste and subtle wit. As a writer he had always displayed great learning, unusual force of style and elegance of diction, and in his intercourse with others he had been unassuming, sensitive, and even timid. Yet the autopsy showed such coarseness and thickness of the convolutions that M. Broca pronounced them to be characteristic of an inferior brain. The fossa or depressions, regarded by Gratiolet as a simian character, and as a sign of cerebral inferiority, which are often found in women, and in some men of undoubted intellectual inferiority, were very much marked, especially on the left parieto-occipital. But the cranial bones were at some points so thin as to be translucent; the cerebral depressions were deeply marked, the frontal suture was not wholly ossified, a decided degree of asymetry was manifested in the greater prominence of the right frontal, while, moreover, the brain weighed 1,468 grammes, *i.e.* about 60 grains above the average given by M. Broca for M. Asseline's age. The apparent contradictions between the weight of the brain and the great development of the anterior parts on the one hand, and the marked character of the parieto-occipital depressions on the other, attracted much attention, and the members of the Société d'Anthropologie have been earnestly invited by M. Hovelacque, in furtherance of science, to join the Société d'Autopsie, to which anthropology is already indebted for many highly important observations. This Society is forming a collection of photographs of its members which are taken in accordance with certain fixed rules.

M. Chervin has drawn attention to the frequency of stammering in the south of France, where from 12 to 13 cases are noted for every 1,000, while in the eastern departments the proportion is only 1 for every 1,000. It has been assumed that the defect was in many cases simulated to avoid the conscription; but according to the Abbé Petitot, there are two districts in the Bouches-du-Rhone, where all the inhabitants (15,000), stammer. This he ascribes to long continued inter-marriages among the communities, and to a consequent degeneracy of the race; and M. Chervin is of opinion that meningitis, induced by the great solar heat, which occasions so high an infantile mortality in this region, may possibly, when not fatal, leave an exceptionally great tendency to stammering.

M. Broca, with his usual diligence, has continued to work out his system of *cerebral topography* in man and in the lower animals; and he has lately presented the society with a large number of cranial moulds, on which every convolution, lobe, or other part, is distinctly marked by different colours, in accordance with sex, age, and race. M. Broca has also made the difference of position of the occipital foramen in man and animals the subject of two interesting papers, the former of which was laid before the society in May, 1877. Following up the investigations of Daubenton, who, as early as 1764 made this a subject of inquiry, M. Broca, after a long course of determinations which he gives in detail, has summed up the results of his labours in the proposition that while in all animals but man the orbito-occipital angle is *constantly positive*, in man it is almost always

negative. It is invariably so in European races, where the differences oscillate between -5° and -39°. In the inferior races it may amount to $+5^\circ$; in adult anthropoids on the other hand, the minimum is found as high as $+32$, while in some gorillas it amounted to $+45$. In women the orbito-basilar angle is habitually from 2 to 3 degrees less than in men.

The decrease in the population of France still continues to excite much speculation. In tome 12, sér. 2, of the *Bulletins* will be found a suggestive paper by M. Després, on the relation between the birth-rate of a country and its enforcement of restrictive enactments intended to diminish the result of public immorality. In comparing Belgium with France a difficult question suggests itself in the fact, that while both countries are under sanitary official supervision, and Belgium next to France has the lowest birth-rate, it has 279 legitimate births against every thousand married women between the ages of 15 and 50, although France has only 174 in the 1,000. The latter has, however, the large number of 140 married women of those ages in every 1,000, while the former has only 105 in the 1,000. In England, on the other hand, before the enactment of any sanitary restrictions, 248 legitimate births were registered for every 1,000 married women of the given ages, (the proportion of married women from 15 to 50 being 133 in the 1,000). But while in this country 120 for every 1,000 men marry between the age of 20 and 25, in Belgium only 33, and in France not quite that number, out of every 1,000 men marry at the same age. This later marriage of the men M. Després regards as an important factor in the lowness of the French birth-rate.

VOLCANIC PHENOMENA AND EARTHQUAKES DURING 1878

THE statistical review of volcanic phenomena during 1878, which Prof. Fuchs has recently published, and which forms the continuation of many previous statistical accounts of the same nature (see NATURE, vol. xv. p. 557, and vol. xviii. p. 241) shows the unusually large number of *twelve* eruptions in the course of the year. Most of them occurred in remote localities and gave evidence of the activity of volcanoes which were generally but little known, and which are all difficult of access. It is true, however, that Mount Vesuvius also, the last eruption of which had taken place in 1872, but which already during 1877 had shown symptoms of the re-awakening of the volcanic process, again entered into a period of activity on April 20, 1878. The mountain ejected ashes, frequent slight shocks occurred, a thick column of smoke ascended, and at the end of September a scanty flow of lava took place. This increased during the night of September 22-23 and the lava descended as far as the Atrio del Cavallo; but afterwards the volcanic activity sank down into the ordinary solfatara-state, which was only interrupted by little periodical explosions on October 11, and by the flow of little streams of lava from November 1 to November 9.

At the southern point of South America active and hitherto unknown volcanoes were repeatedly seen by passing ships, viz. on January 10 and 18; one of them is situated upon the middle island in the English Narrows, the other on the South American continent in about 48° 56′ lat. S.; this one was conspicuous by a majestic column of smoke, ejected from a high snow-clad mountain, and rising to a height of some 300 metres.

At the same time a great eruption occurred in the island of Tanna, the well-known and very active volcanic island in the archipelago of the New Hebrides. On January 10, at 10 a.m., between the so-called Sulphur Bay and the old crater, a new eruption cone formed; the outbreak was accompanied by a mighty tidal wave which inundated a great part of the island. In spite of its violence the eruption lasted only a short time, but on February 4, a second outbreak followed which also did great damage.

Simultaneously yet another eruption happened. Its seat was the large island of Birara, in the group of New Britain. The northern part of the island was completely devastated, and its coasts rendered inaccessible through enormous masses of pumice stone, which covered the sea for many miles. Formerly, no volcano had been known there. We have repeatedly referred to the masses of floating pumice stone in the vicinity of the Solomon Islands, through which, as Captain Harrington reported, ships had to force their way for two or three days. It is very probable that this pumice stone originated from the eruption on Birara, and not from some submarine eruption, as was generally supposed at the time of the occurrence. It is true that there are two volcanoes in the Solomon Islands, the Semoya and the Lammat upon the island of Guadalcanar, but from neither were any eruptions reported during 1878.

The third eruption of February, took place from the volcano Isluga in South America (lat. 19° 10′, S), which mountain had been inactive since 1869. The outbreak was accompanied by a fearful earthquake, and so great were the masses of lava ejected that the villages of Cariquima, Carima, Sotoca, and Chiapa, all situated at more than five leagues' distance from the volcano, were completely destroyed by the incandescent streams.

Smaller volcanic eruptions occurred from Mount Hecla (from February 27, to the end of March), from the Asamayama in Japan, from the Cotopaxi near Quito (in October), from the Tepaco, the Sitna, and the Isalco in San Salvador. The eruptions in the Aleutian and Society Islands were of greater importance. In the volcanic series of the Aleutian islands, the volcanoes on Amukta, Tscheguluk, and the Vsevidok volcano (almost 2,800 metres high) on Umnak were in eruption. In the Society Islands, according to the report of Captain Evers, the islands of Raiatea, and Borabora were completely devastated by the action of volcanoes.

At the end of the list of lava-eruptions Dr. Fuchs records the great mud-eruption of one of the well-known mud-volcanoes near Paternò in Sicily. After repeated shocks of earthquake in the province of Catania spreading over two months, this eruption began on December 10, numerous craters ejecting streams of mud with great noise. Several of these craters were continuously active, as the mud was of little consistency, and freely permitted the ascending gases to escape. The others had explosions from time to time, as the crater basin was filled with much thicker mud, which prevented the gases from passing upwards until their tension was sufficiently high, and they ejected the mud in high rays. At the end of the year this mud-eruption was still progressing with unabated force.

The number of earthquakes reported during 1878 amounts to 103. But amongst these there are many complete earthquake-periods during which shocks and oscillations lasted with short intervals for hours, days, and even for several weeks in the same locality. If we would or could count all the separate shocks which occurred, a very high total would be reached. Thus in the comparatively unimportant earthquake of Zengg twenty shocks were counted, and in the great earthquake of Terapaca in the night of January 23 no less than forty shocks, while the oscillations lasted here almost without interruption until April 12. An earthquake on the island of Tanna (New Hebrides) lasted for four weeks, and in the province of Catania the oscillations succeeded each other almost without interruption from October 4 to November 19.

The earthquakes were most frequent in winter and autumn, thirty-nine occurring in winter, twenty-six in autumn, and nineteen each in summer and spring.

The most violent and most destructive of all these phenomena happened on January 23 in that district of Peru and Bolivia in which the terrible earthquake of 1868 took place. The province of Terapaca suffered more than any other. Here, with the earthquake of May 9, 1877, which in violence was hardly surpassed by that of 1868, a great and considerably extended period of frequently-recurring oscillations had begun, amongst which the earthquake of January 23, 1878, was prominent by its particular force. At Iquique it began at 7.55 P.M., and the shocks continued during the whole night. As usual, the subsequent tidal-wave did still greater damage than the earthquake itself, and this was particularly the case at Arequipa, Pica, Mantilla, Pisaqua, Arica, and Terapaca.

The earthquake on October 2, in the southern part of the republic of San Salvador, was also very violent. In the town of Incuapa almost all the houses were destroyed, and many of the inhabitants perished. In the vicinity a number of villages disappeared entirely. The motion of the soil was first undulatory and ended with a terrible shock.

Of European earthquakes the following must be mentioned specially:—

On January 28, about noon, an earthquake shook the north-western part of France and the south of England. It was particularly distinct in Normandy, at Rouen, Havre, and Dieppe. Even in Paris the shock was so considerable that several houses were endangered. In England it occurred between 11.45 and 11.50 A.M., and was observed at Greenwich, London, Brighton, Southampton, Cowes, and several other places.

Repeatedly shocks were felt in north-western Switzerland and at the south-west corner of the Black Forest. The first and more marked phenomenon happened on January 16, and con-

sisted of several shocks separated by short intervals. These shocks were noticed at Basel, Brugg, Solothurn, on the Swiss side of the Rhine, and at Lörrach, Schopfheim, Waldshut, &c., on the Badish bank. They recurred at Basel on January 17, and on March 29 they were again felt in the whole area described, and then even at Freiburg and Strasburg.

Other instances of repeated earthquakes are :—

Innsbruck (January 3, 10, 11, February 2, August 9).

Gross Gerau (January 2, March 25).

Lisbon (January 26, 27, June 8).

Piemont (repeated shocks on November 25).

Constantinople, Ismid, and Brussa (continual shocks from 19 to end of May).

The damage done by the last-mentioned phenomenon at Ismid and Brussa on April 19 was very considerable; the little town of Esmé was quite destroyed, and many inhabitants lost their lives. The English fleet, which happened to be anchored in the Bosphorus at the time, noticed the oscillations, and on board of one of the ships it was believed that the others were making torpedo experiments, and consequently looked out for shelter.

Less remarkable by its violence than by its enormous extent considering its intensity, was the Low-Rhenish earthquake of August 26. The observations in this case were unusually exact and numerous, which gives additional interest to the occurrence. It began about 9 A.M., and was best observed in the city of Cologne. Here it consisted of an undulatory rising and sinking of the ground, which increased in intensity to such an extent that some buildings began to oscillate ominously. On the cathedral tower the smaller bell struck several times and the wavering pillars in St. Gereon's Church caused such a panic among the congregation, that all rushed out. In many parts of the city the walls of houses showed cracks. At the end of the oscillations a dull subterranean noise was heard and a second shock was observed by many persons. In almost all localities in the Rhenish Province, from Cleve and Emmerich to Kyllburg, Ottweiler, and Montjoie the observations of the phenomenon were similar to those made at Cologne; the same was the case on the opposite bank of the Rhine, at Düsseldorf, Wiesbaden, Münster, and other places. At Aachen (Aix-la-Chapelle) five distinct shocks were noticed; at Elsdorf (on the Neuss-Düren Railway) no less than eighteen until the morning of August 27; and at Düren and Buir their number was but little below this figure.

The area struck by the first shock, on August 26 at 9 A.M., may have measured over 2,000 geographical square miles, as its outlines may be indicated as follows:—Arnsberg and Hanover in the north, Offenbach on the Main and Michelstadt in the Odenwald in the south-east, Strasburg, Paris, and Charelville in the south, Liége and Brussels in the west, and Utrecht in the north-west.

Prof. Klinkerfues has collected the most reliable observations of time and reduced them to the meridian of Paris. According to these calculations the earthquake happened at Cologne at 8h. 38·7m., at Strasburg at 8h. 39·9m., at Göttingen at 8h. 40·9m., at Hanover at 8h. 42·4m., and at Paris at 8h. 45·0m. If the starting point of the oscillations according to number and intensity of the shocks be supposed to have been situated about 2·5 geographical miles to the west of Cologne, the above indications of time give a velocity of the earthquake in the ground of 6·78 geographical miles, with a probable error of $\pm$ 0·48 miles. The depth of the original starting-point is unknown. Prof. Klinkerfues is of opinion that it laid between 6·3 and 8·7 geographical miles from the surface. It is remarkable that the phenomenon was only noticed at the surface, and was all the more intense the higher the observer was above the ground. Many observations were made both at Cologne and at Hanover, which show that the oscillations were far more considerable in the upper storeys of houses than in the lower ones. At Remagen the shock was so great on the upper floor of the school-building that teachers and school-children rushed terrified into the street, while on the ground floor the phenomenon was hardly noticed; the workmen on the towers of Cologne Cathedral saw the scaffolding oscillate to such an extent that they feared for their lives, and a water-tank on the vault of the choir was almost entirely emptied. Yet not one of 1,100 miners working at a depth of 300 metres at Altessen noticed the least shock.

For a long time afterwards shocks occurred at Elsdorf and Buir. At the latter place they were observed on August 26, 27, 28, 29, September 2, October 24, December 3 and 10. Also in other places of the same area the shocks were repeated, so at Remagen (September 3), Wiesbaden (September 14), Osterrath and Crefeld (September 18), Cologne (December 10), Luxemburg and Namur (December 15).

With almost all earthquakes of slight intensity it is very difficult to determine to what class of earthquakes they belong. Thus in the Low-Rhenish earthquake no symptom points to any particular cause. We may surmise volcanic influence, because the most intense and most numerous shocks occurred near the north-western slope of the Eifel-plateau; but with perhaps greater reason we may look for the cause of the phenomenon in the Rheno-Belgian coal district. Altogether the earthquake of August 26 seems to be but a link in a great earthquake-period, which for some years past has been causing lasting changes in the coal-deposits of that neighbourhood. The names of Herzogenrath, Kohlscheid, Eschweiler, &c., recur in every one of Dr. Fuchs's yearly accounts, and apart from numerous weaker oscillations of small extent, considerable earthquakes occurred in this district from September 28 to November 12, 1873, and on June 24, 1877.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

It is stated that the draft charter of the proposed Victoria University has, in accordance with the request of the Lords of the Privy Council, been submitted to that body. According to this draft, the University would have the power of conferring upon all persons, whether male or female, who have pursued a regular course of study in any of its colleges and passed its examinations, all degrees which can be conferred by any other University of the kingdom, with the exception of medical degrees, the Privy Council having declined to confer power as to these at a time when legislation on the whole subject of medical degrees and the licensing power for the practice of medicine has been proposed to Parliament and still remains unsettled. The charter, it is stated, contains provisions for establishing a convocation of graduates of the University, with appropriate rights and functions.

In the late Higher Local Examinations of Cambridge University, Physiology and Experimental Physics were introduced as separate subjects in Group E for the first time. One student, Miss A. Johnson, of Cambridge, passed in Physics, and out of sixteen who entered their names in Physiology, in which subject Mr. J. N. Langley, Fellow of Trinity College, was examiner, eleven passed, but no candidate obtained the mark of distinction. Only three passed in Zoology out of eighteen candidates; but two were distinguished; the failures were about three-fifths of the thirty-four candidates in Botany, and three obtained distinction. Twenty-two passed in Geology and Physical Geography, five obtaining the mark of distinction. In the first class of Group E four students are placed: Miss C. E. Cross, educated at 56, Regent Street, Cambridge, is distinguished in Botany and Geology, and passes in Chemistry; Miss L. M. Passavant, of De la Haye House, Leeds, is distinguished in Botany and Zoology; the candidate numbered 294, Leeds, name not published, is distinguished in Geology and Zoology, and has passed in Physiology; Miss M. A. Broadhurst, Liverpool College for Girls, is distinguished in Geology and Chemistry. Six passed Second Class in Group E, and twenty-eight were placed in the Third Class, to attain which passing in one subject is required, no more than three to be taken in any one year; others may be taken in subsequent years. In Group C (Mathematics) only two obtained distinction, namely, A. G. Lee, Dedham, Essex, and C. E. Oldaker, Chesterton Road, Cambridge, and eight obtained a First Class. The award of Scholarships dependent on the results of this examination has not yet been known.

About three years ago publicity was given to a proposal by Mr. Holloway, of Oxford Street, to expend a considerable amount of money in the erection of a college for the higher education of women. Since that time Mr. Holloway has purchased about ninety-five acres of land at Egham, near Virginia Water, known as the Mount Lee Estate, and has vested the same in trustees. Before deciding upon the form of the building, Mr. Holloway and his architect, Mr. W. H. Crossland, visited the principal collegiate institutions in Europe, and during the past year the plans and specifications have been completed. We now learn that a contract has been actually signed by Mr. Holloway for the building of the college within four years, the contract price being upwards of 250,000*l*., exclusive of fittings

and furniture. The building will be in the form of a double quadrangle, 510 feet from east to west, and 350 feet from north to south. The main buildings will be five storeys in height, and there will be cloisters 10 feet in width on two sides of each quadrangle. The style is to be that known as French Renaissance, and will be carried out in Portland stone and red brick. The object and scope of the college have been the subject of great consideration, and Mr. Holloway has had the advice and assistance of a large number of persons interested in the education of women. The proposed constitution of the college, to be embodied in a trust-deed, will, among other things, set forth that its object is to afford the best education suitable for women of the middle and upper middle classes, and it is intended to be mainly self-supporting. The trustees are to be a corporate body with perpetual succession, and to have all the usual powers and privileges. The governing body will consist of twenty-one persons, to be appointed partly by the University of London and partly by the Corporation of London, and it is stipulated that a certain portion shall always be women. Religious opinions are not in any way to affect the qualification for a governor. It is the founder's desire that power by Act of Parliament, Royal Charter, or otherwise, should be eventually sought to enable the college to confer degrees, after due examination, and that until such power is obtained the students shall qualify themselves to pass the women's examination of the London University, or any examination of a similar or higher character which may be open to women at any of the existing universities of the United Kingdom. The curriculum shall not be restricted to subjects enjoined by any existing university. Instead of being regulated by the traditions and methods of former ages, the system of education should be mainly founded on studies and sciences which the experience of modern times has shown to be most valuable and as best adapted for the intellectual and social requirements of students. The governors will, therefore, be empowered to provide instruction in any subject or branch of knowledge which shall appear to them from time to time most suitable for the education of women; and the curriculum of the college will not discourage students who may desire a liberal education apart from the Latin and Greek languages. Proficiency in classics is not to entitle students to rewards of merit over others equally proficient in other branches of knowledge. It is intended to provide twenty founder's scholarships of the value of 40*l*. each, tenable for not more than two years in the college. No professor will be required to submit to any test concerning his or her religious opinion, and denominational theology is not to be taught. The principal of the college must be a lady, and duly qualified lady physicians and surgeons are to be resident in the college. Mr. Holloway has determined to personally superintend the erection of the building, and has agreed to provide an endowment fund of 100,000*l*., in addition to any fund that may be derived from the sale of such portion of the Mount Lee estate as may not be required for the purposes of the college.

THE following is the list of candidates successful in the competition for the Whitworth Scholarships, 1879, in connection with the Science and Art Department:—John Hardisty, engineer; George Harrison, millwright; Edward Shaw, engineer apprentice; John A. Simpson, engineer; John W. Geddes, mechanic; Sydney J. Harris, engine fitter; Thomas E. Sackfield, mechanic; John A. Brodie, engineer apprentice. As the result of the final competition of scholars appointed in 1876, Mr. Henry S. H. Shaw has received the first prize of 200*l*., and Mr. Jerdan Nichols the second of 100*l*.

THE first Siberian university at Tomsk will be definitely opened for the term of 1879-80. The Czarewitch has signified his intention of being present at the inauguration.

FROM a report which has been sent us of the awards made at the conclusion of the session of the Johns Hopkins University, we notice that out of twenty Fellows appointed for 1879-80, twelve were in physical and biological science, all of them from other colleges than the Johns Hopkins, one of them being from the University of Tokio, Japan. The public spirit of the president and professors is shown in the fact that they have subscribed 500 dollars to be divided as scholarships to two meritorious students next year. In consideration of marked ability in the study of mathematics exemplified during a year's residence in Baltimore and previously, the trustees have invited Miss Christine Ladd to continue her mathematical studies in this university, and have voted that she may receive an honorary stipend, equal to that bestowed upon those who are appointed to fellowships. The trustees promised their aid to a specified amount for the encouragement of a journal of philology, to be published under the editorial control of Prof. Gildersleeve. This will be the fourth serial encouraged by the trustees—the others being the *Journal of Mathematics*, under Prof. Sylvester; the *Journal of Chemistry*, under Prof. Remsen; the *Biological Papers*, under Prof. Martin. The *Chesapeake Zoological Papers*, edited by Dr. Brooks, were published at the cost of a few liberal citizens of Baltimore. Arrangements have been matured for the continuance of the Chesapeake Zoological Laboratory during the ensuing year. The United States Fish Commission, under Prof. S. F. Baird, and the Maryland Fish Commission, under Major T. B. Ferguson, co-operate in this laboratory with the Johns Hopkins University.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, August 4.—M. Daubrée in the chair.—**The following papers were read**:—On the recent tornado in the United States, and on records of Buffon's and Spallanzani's observations of whirlwinds, by M. Faye.—Remarks by M. Berthelot on M. Wurtz's paper on hydrate of chloral.—Secreting and circulating effects produced by the faradisation of the nerves which traverse the tympanum, by M. A. Vulpian.—Supplementary note on the theory of the pulsations of the heart and arteries and their registration, by M. Bouillaud.—On the origin of hail, and on some whirlwinds in which the air was drawn upwards, by M. Colladon.—On the theory of fertilisation, by M. Dechant.—Note on the rotation theory of heavenly bodies, by M. Mougeolle.—A number of communications relating to *Phylloxera vastatrix*, by MM. Gayon and Millardet, G. Foex, A. Quercy, Borel, and H. Barthélemy, were read.—Observations of the occultation of Antares on July 28 last, by C. Flammarion.—On the normal calorific spectrum of the sun, and of the incandescent platinum lamp (Bourbouze), by M. Mouton.—Some observations on M. Mouton's paper, by M. P. Thenard.—On the vibrations on the surface of liquids, by M. F. Lechat.—On Ampère's currents by M. Trève.—On magnets, by the same.—On the distillation of liquids under the influence of static electricity, by M. D. Gernez.—On the employment of the diffusion method in the study of the phenomena of dissociation, by M. L. Troost.—On the action of pyrogallate of potassium upon nitric oxide, by M. G. Lechartier.—On solid hydrocyanic acid, by MM. Lescœur and A. Rigaut.—On synthetic methylpropylcarbinol, by J. A. Le Bel.—On the non-existence of a soluble alcoholic ferment, by M. D. Cochin.—On the colouring matter of *Palmella cruenta*, by Mr. T. L. Phipson.—On the vital properties of cells and on the appearance of their nuclei after their death, by M. L. Ranvier.—On the lymphatics of the perichondrium, by Messrs. G. and Fr. E. Hoggan.—Note by M. L. Hugo, on a number representing the sphere among the ancients.

CONTENTS

THURSDAY, AUGUST 21, 1879

WEATHER CHARTS FOR THE NORTHERN HEMISPHERE

WE present to our readers with this number a copy of the latest work of the United States Signal Office—the Monthly International Weather Chart of the Northern Hemisphere based on simultaneous observations. The copies are the first published for distribution in Europe, and are at our request furnished from Washington. The work marks an important step in meteorological progress. The origin and purposes of the chart and its connection with others are sufficiently set forth in the following extracts from the Annual Report of the Chief Signal Officer to the Hon. Secretary of War of the United States:—

"The proposition adopted at the congress of persons charged with meteorological duties, assembled at Vienna in 1873, and to the affect that it is desirable, with a view to their exchange, that at least one uniform observation, of such character as to be suited for the preparation of synoptic charts, be taken and recorded daily and simultaneously at as many stations as practicable throughout the world, has continued to have practical effect.

"By authority of the War Department, and with the courteous co-operation of scientific men and chiefs of meteorological services representing the different countries, a record of observations taken daily, simultaneously with the observations taken throughout the United States and the adjacent islands, is exchanged semi-monthly. These reports are to cover the territorial extent of Algiers, Austria, Australasia, Belgium, Great Britain, China, Central America, Denmark, France, Germany, Greece, Greenland, India, Italy, Iceland, Japan, Mexico, Morocco, the Netherlands, Norway, Portugal, Russia, Spain, Sweden, Switzerland, Turkey, Tunis, British North America, the United States, the Azores, Sandwich Islands, Malta, Mauritius, West Indies, South Africa, and South America.

"On July 1, 1875, the daily issue of a printed bulletin, exhibiting these international simultaneous reports, was commenced at this office, and has been since maintained. A copy of this bulletin is furnished each co-operating observer. The results to be had from the reports thus collated are considered as to be of especial importance. The bulletin combines, for the first time of which there is record, the labours of the nations in a work of this kind for their mutual benefit. There is needed only the assistance to be had from the naval forces of the different powers (that of the navies of the United States and of Portugal being as heretofore related already given to extend the plan of report upon the seas) to bring more fully within the scope of study observations practically extending around the northern hemisphere. This end is to a great extent already attained.

"In this connection the office has to acknowledge the cordial and valuable co-operation of the meteorological services of the different countries, represented as follows:—

"Algiers, by General Teissier, Commandant Supérieur du Génie; Austria, by Prof. Dr. Julius Hann, Director of the Imperial and Royal Central Meteorological Institute at Vienna; Belgium, by J. C. Houzeau, Director of the Royal Observatory at Brussels; Great Britain, by Robert H. Scott, F.R.S., Secretary of the Meteorological Council, London; Alexander Buchan, M.A., F.R.S.E., Secretary of the Scottish Meteorological Society, Edinburgh, and the respective observers; Costa Rica, by Señor Federico Maison, Director of the Central Office of Statistics and Meteorology; Denmark, by Capt. N. Hoffmeyer, Director of the Royal Danish Meteorological Institute at Copenhagen; France, by U. J. Le Verrier, Director of the Paris Observatory, Prof. E. Mascart, Director of the Central Meteorological Bureau of France, and the respective observers; Germany, by Prof. Dr. Geo. Neumayer, Director of the German Naval Observatory, Hamburg; Greece, by Prof. Dr. J. F. Julius Schmidt, Director of the Royal Observatory at Athens; India, by H. F. Blanford, Meteorological Reporter to the Government of India; Italy, by the Minister of Agriculture, Industry, and Commerce, and the respective observers; Japan, by the Imperial Meteorological Observatory, and the Imperial University of Tokei, Japan; Mexico, by Señor Mariano Barcena, Director of the Central Meteorological Observatory in the City of Mexico, and the respective observers; Netherlands, by Prof. Buys Ballot, Director of the Royal Meteorological Institute of the Netherlands at Utrecht; Norway, by Prof. H. Mohn, Director of the Royal Norwegian Meteorological Institute at Christiania; Portugal, by J. C. de Brito Capello, Director of the Meteorological Observatory of the Infante Don Luiz, at Lisbon; Russia, by Prof. H. Wild, Director of the Imperial Central Physical Observatory of Russia, at St. Petersburg; Spain, by Antonio Aguilar, Director of the Royal Observatory at Madrid, and the respective observers; Sweden, by Prof. R. Rubenson, Director of the Royal Swedish Meteorological Institute at Stockholm, and of Dr. H. H. Hildebrandsson, Chief of the Meterological Division of the Upsala Observatory; Switzerland, by Prof. R. Wolf, Director of the Observatory at Zurich, and of Prof. E. Plantamour, Director of the Observatory at Geneva; Turkey, by A. Coumbary, Effendi, Director of the Central Observatory at Constantinople, and of Prof. C. V. A. van Dyck, Superintendent of the Lee Observatory at Beirut; Canada, by Prof. G. T. Kingston, Director of the Magnetic Observatory at Toronto, and Superintendent of the Meteorological Office of the Dominion of Canada, and the respective observers; United States Navy, by Navy Department, through Rear-Admiral Daniel Ammen, and Commodore W. D. Whiting, U.S.N., Chiefs of the Bureau of Navigation; and by individual observers at other points.

"The Office has to regret the death since the date of the last annual report of the following distinguished colabourers in the work:—Urbain Jean Joseph Le Verrier, Director of the Paris Observatory, Prof. Ernst Quetelet, Director of the Royal Observatory at Brussels, Prof. Edward Heis, of Münster, and Prof. Pietro Angelo Secchi, of Rome.

"A number of observations taken on vessels at sea to complement the synchronous reports of the service, and at the request of the department, have been received on the form provided for the purpose, paper 49. Their utility is evident in the study of storms approaching our coasts or which endanger vessels sailing from our ports.

"The co-operation of the navy of the United States in the taking of observations simultaneously with the system adopted at this office, wherever naval vessels of the United States may be, as assured by the general order of the Secretary of the Navy, dated December 25, 1876, has largely increased the data of this class. This co-operation has been skilfully rendered by the Navy Department and the United States Navy, through the Chief of the Bureau of Navigation.

"The people of the United States are thus the first nation whose army and navy co-operate, as all armies and navies should, under official orders, in the taking of simultaneous observations wherever the forces may be.

"In view of the existence of the system of simultaneous reports to be made at sea by the vessels of the naval and commercial marines of the United States and other nations, and to provide for its extension, carefully tested

barometers of the best make have, since the date of the last annual report, been prepared and located, as standards, at the ports of New York and San Francisco.

"These barometers have been publicly located to afford means for comparison of the ships' barometers of the shipping of all nations. The instruments, while carefully guarded, are easily accessible. Public notice is given of the location, and a sergeant of the Signal Corps attends daily to give information and to take charge of any ship's barometer which may be brought for comparison (Paper 48).

"The standard barometer for the use of shipping in the Atlantic Ocean is located at the Maritime Exchange, in New York City; the standard barometer for the use of shipping in the Pacific Ocean is located at the Merchants' Exchange, in the city of San Francisco.

"The officers of the Signal Service at the different cities and ports of the United States and upon the sea-coast offer every facility and aid in their power to the vessels of any nation.

"With the plans for charting now adopted at this office, and with the reports now received here, it appears that the meteoric changes occurring over a great portion of the continents north of the equator can be charted with an accuracy sufficient to permit careful and valuable study. This charting to be of the best attainable value, must be supplemented from the records of observations had on the seas. A ship at sea becomes one of the best of stations for a simultaneous system. The value of the record is enhanced by the change of the ship's location occurring within each period of twenty-four hours. There is no sea-going vessel but which carries human life, and each ought to carry by compulsion, if need be, meteorological instruments. The smallest craft, in caring for its own safety, may use them enough to add to the value of the most extensive record. There is no nation without interest in the work proposed to be based upon exchanged simultaneous reports, and none has hitherto hesitated, when the subject has been properly presented, to aid in a duty which, so easily done as to require very little effort on the part of any one person, has for its object a good to mankind. The work cannot, from its nature, be for the selfish good of any section.

"A number of the great steamship companies, foreign and domestic, operating the principal commercial sea-routes, have promised and will give their powerful influence and aid.

"The office has the co-operation of the Pacific Mail Steamship Company, through its agents, Williams, Blanchard and Co.; the White Star Line, through its agents, Ismay, Imrie and Co., Liverpool, and R. J. Curtis, New York; the Occidental and Oriental Steamship Company, through its president, George H. Bradbury; the North German Lloyd, through its agents, A. Schumacher and Co.; the American Steamship Company, through its president, H. D. Welsh; the Red Star Line, through its president, James A. Wright, and the Allan Line, through its agents, A. Schumacher and Co.

"The United States bear, in the cases of all maritime observers co-operating in this system, all expenses for forms, postages, &c., when so desired, and not infrequently, and, when necessary, loan the required instruments.

"The number of observations made daily on separate vessels at sea is 100 (Paper 13).

"Research has already gone far enough to indicate the paths by which, if it cannot be directly predicted, it can at least be studied, to learn what sequences to follow conditions reported on or near the eastern coast of Asia, or on the Pacific, will be found on our own western coasts.

"Similar studies will have reference to our own southern and eastern coasts, and to the western coasts of the European continent. The time cannot be far distant when vessels leaving any Atlantic port may be informed whether any notable disturbance exists at sea and where it is likely to threaten the voyage.

"The establishment of permanent ocean stations in lines traversing the oceans over or near the telegraphic cables, and in telegraphic communication with either continent, is not considered impracticable, and has been referred to in a preceding report.

"There is reason to hope that a progress has been made which will eliminate from the study of practical international meteorology some of the difficulties hitherto encountered.

"There are grounds to hope also that the atmospheric conditions and changes of condition can be charted with sufficient accuracy over any extent of the earth's surface.

"If the hope has fruition, meteorological barriers will, as against study, practically cease to exist.

"A copy of the International Bulletin herewith (Paper 27) exhibits the character of the international reports, and that of the information had from each station. The chart accompanying this bulletin shows as nearly as practicable the location of the stations, and foreshadows the duties and reports had from them will make practicable. The number of stations reporting increases.

"While the stations are crowded in some localities, each is useful—each serving to check the work of the other, and each aiding to close the gaps the failure of other stations might sometimes cause. The work is not likely to be abandoned by those in the different countries who have taken part in establishing it, and who share its benefits. If it serve no other purpose than to maintain, as it does, the pleasant co-operation of those charged with the meteorological duties of the different countries, it would be of value. It is hoped that by systems of observations thus extensive, generalisations may be had to permit the announcement of meteoric changes for periods longer in advance than have been hitherto practicable.

"The average number of daily simultaneous observations now made in foreign countries is 293. The total number of *stations* on land and *on vessels at sea from which reports* are entered in the bulletin regularly is 557. The co-operation of the different nations secured by this plan of exchange, as above described, renders the additional cost to the United States of the grand system of reports it makes possible but little more than that of the cost of the preparation, paper, and binding of the International Bulletin and the accompanying charts, a cost which would have to be met in great part for the proper preservation of the records themselves even if the bulletins were not distributed.

"The Chief Signal Officer is gratified to announce in this report that the work of the collection of the reports of international simultaneous observations, carried on in foreign countries in co-operation with the United States, as well as within the territories of the United States and upon the seas thus above referred to, has in the year just passed so far progressed as to have attained one principal result for which it was set on foot. On July 1, 1878, it became possible for the first time in the history of this office to commence the issue, on that date, of a daily international weather map, charted daily and issued daily, each chart based upon the data appearing upon the International Bulletin of simultaneous reports of similar date. The charting extends around the world, and embraces for its area the whole northern hemisphere.

"The daily issue of a chart of this kind, thus daily issued for the first time by the United States, is without a precedent in history. It exhibits the co-operation, for for a single purpose, of the civilised powers of the world north of the equator.

"The studies such charts make possible, the improvement which will come as the work progresses and the area of the chart is better filled with reports of observations carefully elaborated, are fully appreciated by scien tific men. The questions as to the translations of storms

from continent to continent, and of the times and directions they may take in such movements; the movement of areas of high and of low barometer; the conditions of temperature, pressure, and wind-direction existing around the earth at a fixed instant of time, permitting thus the effects of day and night to be contrasted; the distribution and amount of rainfall, and other studies, many and valuable, only suggested by this enumeration, may be by such studies settled. It seems not impossible that in the future questions of climatology, and perhaps others bearing upon the prediction of weather changes far in advance of the time at which these changes may happen, or questions of the character of coming seasons even, may be answered by the researches these charts will make practicable.

"The very great aid and material furnished in this elaborated form gives to the search for generalisation, or for data in the support of theories, was referred to in the last annual report. In frequent cases little more than collation is necessary.

"As a means of better combining the work and the interests of the several nations; of certainly securing that co-operation at sea which will enable the lines of the charting to be drawn as fully and as well over oceans as over continents; and which will give the world ultimately a knowledge as practical of the movement of areas of disturbance in the midst of the seas as is now had of such movements on some continents, the undertaking is of much importance.

"It is an advantage of the charting draughted from simultaneous reports that studies by normals, not possible in any other way, can be made. The normal pressure, temperature, &c., arrived at from observations taken at any one place, at the same and a fixed instant of time every day, become established as to that place and time with accuracy. Many causes of error are eliminated.

"The intercomparison of these normals with the normals taken at other places simultaneously with the first and under the similar condition that the normals to be found for those places are to be from observations taken at those places at a fixed time and on every day, gives results reliable and different from those to be had by the use of normal readings arrived at in any other manner. Normals for the year, for the season, and for the month, may be determined by such procedure. The comparison of such normals will show in the case of abnormal changes in any district or section for any season whether and how they are compensated by compensating variations elsewhere. There are interesting studies as to what sequences there may be to follow such atmospheric variations occurring over any region or country—either in that region or country, or elsewhere—and how and where the compensating variations occur, and with what concomitants or sequences of meteoric changes.

"There is the hope to gain in this way or by studies such study will suggest information to affect the commercial and agricultural interests of the world.

"There is the further hope that as it is more fully realised by the different peoples, how close in the future the practice of such investigations draws, each member of the family of nations will find its own interests in labours of this description, and draw more closely the bonds and join with energy in a work which has so begun to connect them. The undertaking, world-wide in extent, is capable of rendering a world-wide benefit."

The chart before our readers bears information condensed from thirty—one for each day of the month—of the world weather charts above described, and exhibits one path of study to be pursued. It shows for one month the lines of mean pressure, mean temperature, and average wind direction on land and sea within the limits of civilisation on the Northern Hemisphere. The appearance of the map marks the commencement of the first actual and current study of the atmosphere of the whole Northern Hemisphere for practical use.

It will be noticed from the Report that the Chief Signal Officer, General Myer, while pressing forward month after month his plan, commenced on the American Continent nine years ago—in 1870—of mapping by weather charts and simultaneously the Northern Hemisphere, and fixing its success, reaches out a helping hand to every people. The Report asks all nations to stand side by side with the United States in carrying forward the work now marked out, and announces that so far as the United States is concerned the least of the co-operators shall receive the perfected work as fully as the greatest. Every separate observer or ship at sea co-operating in this work receives a copy of the chart he has helped to make. Aside from any national benefit the work is to benefit the human race.

THE BRITISH ASSOCIATION

THE Forty-ninth Annual Meeting of the British Association was opened yesterday at Sheffield, under the presidency of Prof. Allman, F.R.S. The new secretary, Mr. J. E. H. Gordon, has made several innovations in the conduct of the business of the Association, which, when fairly established, will no doubt be decided improvements.

At the end of last week all the arrangements for the meeting were in an unusually forward state. Circulars had been sent to every member of the Association, and all the more prominent members who had replied have been well provided for by private hospitality, unless they desired to be otherwise accommodated. It is expected that the meeting will in all respects be a very good one. At all events, no efforts have been spared by the town of Sheffield to make it so, and the local secretaries and other officers have been at their posts from soon after eight in the morning to late every evening. A handy Guide-Book to Sheffield and its neighbourhood has been compiled for the special use of those attending the meeting of the Association.

There will be an excellent display of all the more recent scientific inventions at the second *soirée* given by the Local Committee on Tuesday the 26th. Independently of the large number of excursions arranged for Saturday the 23rd, and Thursday the 28th, most of the leading manufactories will be opened to the members, or will be visited by parties invited for special days. The Firth College, the gift to the town of Mr. Mark Firth, will now be used for the first time, and will be found admirably adapted for the reception-room and offices. It is to be formally opened for educational purposes in October by Prince Leopold. At one time much anxiety was felt with reference to this building. The long and severe winter delayed operations so much, that but for subsequent great energy it could not have been finished for the meeting. For the last two weeks it has been used for the temporary offices of the Association, though the secretaries and others have been compelled to carry on their business along with all sorts of workmen. If, as originally fixed, the meeting had commenced on August 6, it would have been almost impossible to have used the college for the reception-room.

The Local Committee have had a good deal of trouble, we believe, in the matter of lodging accommodation; but this has happily been surmounted. The citizens of Sheffield have most liberally responded to the request for hospitality, and special arrangements have been made for the adequate refreshment of members who conscientiously attend to the thirsty and appetising work of the Sections; for it seems Sheffield is rather

scantily provided with hotels and restaurants. The list of excursions seems unusually large, there being twenty-four in all for Saturday the 23rd, and Thursday the 28th; all the arrangements for these bespeak the greatest thoughtfulness for the comfort of the members. On Friday evening, the 22nd, a twilight exhibition of Bessemer steel manufacture is to be shown to 100 members at the Phœnix Bessemer Works, Iccles, Rotherham, and on Wednesday next Nunnery and Aldwarke Collieries will be visited.

Ample entertainment has been arranged for in the way of banquets and *conversazioni*, and on Sunday the Archbishop of York and Canon Tristram are to preach in the Parish Church. Altogether the Sheffield meeting promises, if not to be unusually large, to be thoroughly satisfactory so far as local arrangements go.

Inaugural Address of Prof. G. J. Allman, M.D., LL.D., F.R.S.S.L. and E., M.R.I.A., Pres. L.S., President.

It is no easy thing to find material suited to an occasion like the present. For on the one hand there is risk that a presidential address may be too special for an audience necessarily large and general, while on the other hand it may treat too much of generalities to take hold of the sympathies and command the attention of the hearers.

It may be supposed that my subject should have been suggested by the great manufacturing industries of the town which has brought us together; but I felt convinced that a worker in only the biological sciences could not do justice to the workers in so very different a field.

I am not, therefore, going to discourse to you of any of those great industries which make civilised society what it is—of those practical applications of scientific truth which within the last half century have become developed with such marvellous rapidity, and which have already become interwoven with our everyday life, as the warp of the weaver is interwoven with the woof. Such subjects must be left to other occupiers of this chair, from whom they may receive that justice which I could not pretend to give them; and I believe I shall act most wisely by keeping to a field with which my own studies have been more directly connected.

I know that there are many here present from whom I have no right to expect that previous knowledge which would justify me in dispensing with such an amount of elementary treatment as can alone bring my subject intelligibly before them, and my fellow-members of the British Association who have the advantage of being no novices in that department of biology with which I propose to occupy you, will pardon me if I address myself mainly to those for whom the field of research on which we are about to enter has now been opened for the first time.

I have chosen, then, as the matter of my address to you to-night, a subject in whose study there has during the last few years prevailed an unwonted amount of activity, resulting in the discovery of many remarkable facts, and the justification of many significant generalisations. I propose, in short, to give you in as untechnical a form as possible some account of the most generalised expression of living matter, and of the results of the more recent researches into its nature and phenomena.

More than forty years have now passed away since the French naturalist, Dujardin, drew attention to the fact that the bodies of some of the lowest members of the animal kingdom consist of a structureless, semi-fluid, contractile substance, to which he gave the name of Sarcode. A similar substance occurring in the cells of plants was afterwards studied by Hugo von Mohl, and named by him Protoplasm. It remained for Max Schultze to demonstrate that the sarcode of animals and the protoplasm of plants were identical.

The conclusions of Max Schultze have been in all respects confirmed by subsequent research, and it has further been rendered certain that this same protoplasm lies at the base of all the phenomena of life, whether in the animal or the vegetable kingdom. Thus has arisen the most important and significant generalisation in the whole domain of biological science.

Within the last few years protoplasm has again been made a subject of special study; unexpected and often startling facts have been brought to light, and a voluminous literature has gathered round this new centre of research. I believe, therefore, that I cannot do better than call your attention to some of the more important results of these inquiries, and endeavour to give you some knowledge of the properties of protoplasm, and of the part it plays in the two great kingdoms of organic nature.

As has just been said, protoplasm lies at the base of every vital phenomenon. It is, as Huxley has well expressed it, "the physical basis of life." Wherever there is life, from its lowest to its highest manifestations, there is protoplasm; wherever there is protoplasm, there, too, is life. Thus, coextensive with the whole of organic nature—every vital act being referable to some mode or property of protoplasm—it becomes to the biologist what the ether is to the physicist; only that instead of being a hypothetical conception, accepted as a reality from its adequacy in the explanation of phenomena, it is a tangible and visible reality, which the chemist may analyse in his laboratory, the biologist scrutinise beneath his microscope and his dissecting needle.

The chemical composition of protoplasm is very complex, and has not been exactly determined. It may, however, be stated that protoplasm is essentially a combination of albuminoid bodies, and that its principal elements are, therefore, oxygen, carbon, hydrogen, and nitrogen. In its typical state it presents the condition of a semi-fluid substance—a tenacious, glairy liquid, with a consistence somewhat like that of the white of an unboiled egg.[1] While we watch it beneath the microscope movements are set up in it; waves traverse its surface, or it may be seen to flow away in streams, either broad and attaining but a slight distance from the main mass, or else stretching away far from their source, as narrow liquid threads, which may continue simple, or may divide into branches, each following its own independent course; or the streams may flow one into the other, as streamlets would flow into rivulets and rivulets into rivers, and this not only where gravity would carry them, but in a direction diametrically opposed to gravitation; now we see it spreading itself out on all sides into a thin liquid stratum, and again drawing itself together within the narrow limits which had at first confined it, and all this without any obvious impulse from without which would send the ripples over its surface or set the streams flowing from its margin. Though it is certain that all these phenomena are in response to some stimulus exerted on it by the outer world, they are such as we never meet with in a simply physical fluid—they are spontaneous movements resulting from its proper irritability, from its essential constitution as living matter.

Examine it closer, bring to bear on it the highest powers of your microscope—you will probably find disseminated through it countless multitudes of exceedingly minute granules; but you may also find it absolutely homogeneous, and, whether containing granules or not, it is certain that you will find nothing to which the term *organisation* can be applied. You have before you a glairy, tenacious fluid, which, if not absolutely homogeneous, is yet totally destitute of structure.

And yet no one who contemplates this spontaneously moving matter can deny that it is alive. Liquid as it is, it is a living liquid; organless and structureless as it is, it manifests the essential phenomena of life.

The picture which I have thus endeavoured to trace for you in a few leading outlines is that of protoplasm in its most generalised aspect. Such generalisations, however, are in themselves unable to satisfy the conditions demanded by an exact scientific inquiry, and I propose now, before passing to the further consideration of the place and purport of protoplasm in nature, to bring before you some definite examples of protoplasm, such as are actually met with in the organic world.

A quantity of a peculiar slimy matter was dredged in the North Atlantic by the naturalists of the exploring ship *Porcupine* from a depth of from 5,000 to 25,000 feet. It is described as exhibiting, when examined on the spot, spontaneous movements, and as being obviously endowed with life. Specimens of this, preserved in spirits, were examined by Prof. Huxley, and declared by him to consist of protoplasm, vast masses of which must thus in a living state extend over wide areas of sea bottom. To this wonderful slime Huxley gave the name of *Bathybius Haeckelii*.

Bathybius has since been subjected to an exhaustive examina-

[1] In speaking of protoplasm as a liquid, it must be borne in mind that this expression refers only to its physical consistence—a condition depending mainly on the amount of water with which it is combined, and subject to considerable variation, from the solid form in which we find it in the dormant embryo of seeds, to the thin watery state in which it occurs in the leaves of Valisneria. Its distinguishing properties are totally different from those of a purely physical liquid, and are subject to an entirely different set of laws.

tion by Prof. Haeckel, who believes that he is able to confirm in all points the conclusions of Huxley, and arrives at the conviction that the bottom of the open ocean, at depths below 5,000 feet, is covered with an enormous mass of living protoplasm, which lingers there in the simplest and most primitive condition, having as yet acquired no definite form. He suggests that it may have originated by spontaneous generation, but leaves this question for future investigations to decide.

The reality of Bathybius, however, has not been universally accepted. In the more recent investigations of the *Challenger* the explorers have failed in their attempts to bring further evidence of the existence of masses of amorphous protoplasm spreading over the bed of the ocean. They have met with no trace of Bathybius in any of the regions explored by them, and they believe that they are justified in the conclusion that the matter found in the dredgings of the *Porcupine* and preserved in spirits for further examination, was only an inorganic precipitate due to the action of the alcohol.

It is not easy to believe, however, that the very elaborate investigations of Huxley and Haeckel can be thus disposed of. These, moreover, have received strong confirmation from the still more recent observations of the Arctic voyager, Bessels, who was one of the explorers of the ill-fated *Polaris*, and who states that he dredged from the Greenland seas masses of living undifferentiated protoplasm. Bessels assigns to these the name of Protobathybius, but they are apparently indistinguishable from the Bathybius of the *Porcupine*. Further arguments against the reality of Bathybius will therefore be needed before a doctrine founded on observations so carefully conducted shall be relegated to the region of confuted hypotheses.

Assuming then, that Bathybius, however much its supposed wide distribution may have been limited by more recent researches, has a real existence, it presents us with a condition of living matter the most rudimental it is possible to conceive. No law of morphology has as yet exerted itself in this formless slime. Even the simplest individualisation is absent. We have a living mass, but we know not where to draw its boundary lines; it is living matter, but we can scarcely call it a living being.

We are not, however, confined to Bathybius for examples of protoplasm in a condition of extreme simplicity. Haeckel has found, inhabiting the fresh waters in the neighbourhood of Jena, minute lumps of protoplasm, which when placed under the microscope were seen to have no constant shape, their outline being in a state of perpetual change, caused by the protrusion from various parts of their surface of broad lobes and thick finger-like projections, which, after remaining visible for a time, would be withdrawn, to make their appearance again on some other part of the surface.

These changeable protrusions of its substance, without fixed position or definite form, are eminently characteristic of protoplasm in some of its simplest conditions. They have been termed "Pseudopodia," and will frequently come before you in what I have yet to say.

To the little protoplasmic lumps thus constituted, Haeckel has given the name of *Protamœba primitiva*. They may be compared to minute detached pieces of Bathybius. He has seen them multiplying themselves by spontaneous division into two pieces, which, on becoming independent, increase in size and acquire all the characters of the parent.

Several other beings as simple as *Protamœba* have been described by various observers, and especially by Haeckel, who brings the whole together into a group to which he gives the name of MONERA, suggested by the extreme simplicity of the beings included in it.

But we must now pass to a stage a little higher in the development of protoplasmic beings. Widely distributed in the fresh and salt waters of Britain, and probably of almost all parts of the world, are small particles of protoplasm closely resembling the *Protamœba* just described. Like it, they have no definite shape, and are perpetually changing their form, throwing out and drawing in thick lobes and finger-like pseudopodia, in which their body seems to flow away over the field of the microscope. They are no longer, however, the homogeneous particle of protoplasm which forms the body of *Protamœba*. Towards the centre a small globular mass of firmer protoplasm has become differentiated off from the remainder, and forms what is known as a nucleus, while the protoplasm forming the extreme outer boundary differs slightly from the rest, being more transparent, destitute of granules, and apparently somewhat firmer han the interior. We may also notice that at one spot a clear spherical space has made its appearance, but that while we watch it has suddenly contracted and vanished, and after a few seconds has begun to dilate so as again to come into view, once more to disappear, then again to return, and all this in regular rhythmical sequence. This little rhythmically pulsating cavity is called the "contractile vacuole." It is of very frequent occurrence among those beings which lie low down in the scale of life.

We have now before us a being which has arrested the attention of naturalists almost from the commencement of microscopical observation. It is the famous *Amœba*, for which ponds and pools and gutters on the house roof have for the last 200 years been ransacked by the microscopist, who has many a time stood in amazement at the undefinable form and Protean changes of this particle of living matter. It is only the science of our own days, however, which has revealed its biological importance, and shown that in this little soft nucleated particle we have a body whose significance for the morphology and physiology of living beings cannot be over estimated, for in *Amœba* we have the essential characters of a CELL, the morphological unit of organisation, the physiological source of specialised function.

The term "cell" has been so long in use that it cannot now be displaced from our terminology; and yet it tends to convey an incorrect notion, suggesting, as it does, the idea of a hollow body or vesicle, this having been the form under which it was first studied. The cell, however, is essentially a definite mass of protoplasm having a nucleus imbedded in it. It may, or may not, assume the form of a vesicle; it may, or may not, be protected by an enveloping membrane; it may, or may not, contain a contractile vacuole; and the nucleus may, or may not, contain within it one or more minute secondary nuclei or "nucleoli."

Haeckel has done good service to biology in insisting on the necessity of distinguishing such non-nucleated forms as are presented by *Protamœba* and the other *Monera* from the nucleated forms as seen in *Amœba*. To the latter he would restrict the word *cell*, while he would assign that of "cytode" to the former.[1]

[1] In every typical cell three parts may be distinguished. There is first the more or less liquid granular protoplasm; secondly the nucleus; and thirdly an external more firm zone of protoplasm, known as the 'cortical layer'—the Hautschicht of the German histologists. All these parts may be regarded as portions differentiated out of the original simple protoplasm. Cells do not, however, always remain on a stage of such simplicity as that presented by *Amœba*. The nucleus is always at its origin quite homogeneous, but as it increases in size it usually manifests a differentiation resulting in a constitution which recent research has shown to be more complex than had been previously supposed; for we often find it to present an external firmer layer, or nuclear membrane, including within it the softer nuclear protoplasm, in which again a network of filaments has been in many instances described.

The structure of the nucleus has been quite recently studied by Flemming (*Arch. f. mikr. Anat.*, Band xvi. Heft 2, 1878), who has given particular attention to this intranuclear network. He maintains that in its completed state the nucleus consists of a parietal firm layer, which incloses, besides specially differentiated nucleoli, a framework (Gerüst) of filaments with a more fluid intervening substance. He further insists on the fact that, with the differentiation of a nucleus, there is introduced a chemical difference between its substance and that of the surrounding cell substance, as shown not only by a different behaviour of the nucleus towards re-agents, but by an actually determined difference of chemical composition.

Klein (*Quarterly Journ. Micr. Sci.* vol. xviii. p. 315) has shown that in the cells of the stomach of *Triton cristatus* there is a delicate intranuclear network of filaments in all respects resembling that described by Flemming; and he further maintains that the network of the nucleus is here continuous, through minute apertures near the poles of the nuclear membrane, with a similar network in the surrounding cell-substance. In this cell-substance he distinguishes two parts—the homogeneous ground substance and the intra-cellular network of filaments.

Flemming, however, will not admit this connection between intra-nuclear and intra-cellular filaments, and Schleicher, as the result of his very recent researches on the division of cartilage-cells ("Die Knorpelzelltheilung," *Arch. f. mikr. Anat.*, Band xvi. Heft 2, 1878), concludes that in these there is no true intra-cellular network, the nucleus being here composed of a multitude of separate rodlets, filaments, and granules surrounded by the nuclear membrane.

The minute granules which are generally seen in the soft protoplasm of the cell do not seem to be essential constituents. They are probably nutritive matter introduced from without, and in process of assimilation and conversion into proper protoplasm. Hanstein has distinguished by the term Metaplasm these granules from the proper homogeneous protoplasm in which they are suspended. The external cortical layer is quite destitute of them: on this devolves the property of protecting the contents from the unfavourable action of outer influences, and to it alone in plants is allocated the property of secreting the cellulose boundary wall.

Several recent observers, but more especially Strasburger ("Studien über das Protoplasma," *Jenaische Zeitschr.*, 1876), have described in the cortical layer of various cells a radial striation, as if formed by excessively delicate rodlets (Stäbchen), placed vertically to the surface and in close proximity to one another. He has seen a relation between these and the cilia on the swarm spores of Vaucheria, where each cilium seems to be supported by a rodlet. That this condition of the cortical layer, however, has not a general feature of cell protoplasm, is certain; it is but a special case of structural differentiation. Indeed, the complex structure which has been detected in the nucleus and in the surrounding cell-protoplasm can scarcely be other-

Let us observe our *Amœba* a little closer. Like all living beings, it must be nourished. It cannot grow as a crystal would grow by accumulating on its surface molecule after molecule of matter. It must *feed.* It must take into its substance the necessary nutriment; it must assimilate this nutriment, and convert it into the material of which it is itself composed.

If we seek, however, for a mouth by which the nutriment can enter into its body, or a stomach by which this nutriment can be digested, we seek in vain. Yet watch it for a moment as it lies in a drop of water beneath our microscope. Some living denizen of the same drop is in its neighbourhood, and its presence exerts on the protoplasm of the *Amœba* a special stimulus which gives rise to the movements necessary for the prehension of nutriment. A stream of protoplasm instantly runs away from the body of the *Amœba* towards the destined prey, envelops it in its current, and then flows back with it to the central protoplasm, where it sinks deeper and deeper into the soft yielding mass, and becomes dissolved, digested, and assimilated in order that it may increase the size and restore the energy of its captor.

But again, like all living things, *Amœba* must multiply itself, and so after attaining a certain size its nucleus divides into two halves, and then the surrounding protoplasm becomes similarly cleft, each half retaining one-half of the original nucleus. The two new nucleated masses which thus arise now lead an independent life, assimilate nutriment, and attain the size and characters of the parent.

We have just seen that in the body of an *Amœba* we have the type of a cell. Now both the fresh waters and the sea contain many living beings beside *Amœba* which never pass beyond the condition of a simple cell. Many of these, instead of emitting the broad lobe-like pseudopodia of *Amœba*, have the faculty of sending out long thin threads of protoplasm, which they can again retract, and by the aid of which they capture their prey or move from place to place. Simple structureless protoplasm as they are, many of them fashion for themselves an outer membranous or calcareous case, often of symmetrical form and elaborate ornamentation, or construct a silicious skeleton of radiating spicula, or crystal clear concentric spheres of exquisite symmetry and beauty.

Some move about by the aid of a flagellum, or long whip-like projection of their bodies, by which they lash the surrounding waters, and which, unlike the pseudopodia of *Amœba*, cannot, during active life, be withdrawn into the general protoplasm of the body; while among many others locomotion is effected by means of cilia—microscopic vibratile hairs, which are distributed in various ways over the surface, and which, like the pseudopodia and flagella, are simple prolongations of their protoplasm.

In every one of these cases the entire body has the morphological value of a cell, and in this simple cell reside the whole of the properties which manifest themselves in the vital phenomena of the organism.

The part fulfilled by these simple unicellular beings in the economy of nature has at all times been very great, and many geological formations, largely built up of their calcareous or silicious skeletons, bear testimony to the multitudes in which they must have swarmed in the waters of the ancient earth.

Those which have thus come down to us from ancient times owe their preservation to the presence of the hard persistent structures secreted by their protoplasm, and must, after all, have formed but a very small proportion of the unicellular organisms which peopled the ancient world, and there fulfilled the duties allotted to them in nature, but whose soft, perishable bodies have left no trace behind.

In our own days similar unicellular organisms are at work, taking their part silently and unobtrusively in the great scheme of creation, and mostly destined, like their predecessors, to leave behind them no record of their existence. The Red Snow Plant, to which is mainly due the beautiful phenomenon by which tracts of Arctic and Alpine snow become tinged of a delicate crimson, is a microscopic organism whose whole body consists of a simple spherical cell. In the protoplasm of this little cell must reside all the essential attributes of life; it must grow by the reception of nutriment; it must repeat by multiplication that form which it has itself inherited from its parent; it must be able to respond to the stimulus of the physical conditions by which it is surrounded. And there it is, with its structure almost on the bounds of extremest simplification, taking its allotted part in the economy of nature, combining into living matter the lifeless elements which lie around it, redeeming from sterility the regions of never-thawing ice, and peopling with its countless millions the wastes of the snow land.[1]

But organisation does not long rest on this low stage of unicellular simplicity, for as we pass from these lowest forms into higher, we find cell added to cell, until many millions of such units become associated in a single organism, where each cell, or each group of cells, has its own special work, while all combine for the welfare and unity of the whole.

In the most complex animals, however, even in man himself, the component cells, notwithstanding their frequent modification and the usual intimacy of their union, are far from losing their individuality. Examine under the microscope a drop of blood freshly taken from the human subject, or from any of the higher animals. It is seen to be composed of a multitude of red corpuscles, swimming in a nearly colourless liquid, and along with these, but in much smaller numbers, somewhat larger colourless corpuscles. The red corpuscles are modified cells, while the colourless corpuscles are cells still retaining their typical form and properties. These last are little masses of protoplasm, each enveloping a central nucleus. Watch them. They will be seen to change their shape; they will project and withdraw pseudopodia, and creep about like an *Amœba*. But, more than this, like an *Amœba*, they will take in solid matter as nutriment. They may be fed with coloured food, which will then be seen to have accumulated in the interior of their soft transparent protoplasm; and in some cases the colourless blood corpuscles have actually been seen to devour their more diminutive companions, the red ones.

Again, there are certain cells filled with peculiar coloured matters, and called pigment cells, which are especially abundant, as constituents of the skin in fishes, frogs, and other low vertebrate, as well as many invertebrate, animals. Under certain stimuli, such as that of light, or of emotion, these pigment cells change their form, protrude or retract pseudopodial prolongations of their protoplasm, and assume the form of stars or of irregularly lobed figures, or again draw themselves together into little globular masses. To this change of form in the pigment cell the rapid change of colour so frequently noticed in the animals provided with them is to be attributed.

The animal egg, which in its young state forms an element in the structure of the parent organism, possesses in the relations now under consideration a peculiar interest. The egg is a true cell, consisting essentially of a lump of protoplasm inclosing a nucleus, and having a nucleolus included in the interior of the nucleus. While still very young it has no constant form and is perpetually changing its shape. Indeed, it is often impossible to distinguish it from an *Amœba;* and it may, like an *Amœba*, wander from place to place by the aid of its pseudopodial projections. I have shown elsewhere[2] that the primitive egg of the remarkable hydroid *Myriothela*, manifests amœboid motions; while Haeckel has shown[3] that in the sponges certain *Amœba*-like organisms, which are seen wandering about in the various canals and cavities of their bodies, and had been until lately regarded as parasites which had gained access from without, are really the eggs of the sponge; and a similar amœboid condition is presented by the very young eggs of even the highest animals.

Again, Reichenbach has proved[4] that during the development of the crayfish the cells of the embryo throw out pseudopodia by which, exactly as in an *Amœba*, the yolk spheres which serve as nutriment for the embryo are surrounded and engulphed in the protoplasm of the cells.

I had shown some years ago[5] that in *Myriothela*, pseudopodial processes are being constantly projected from the walls of the alimentary canal into its cavity. They appear as direct extensions of a layer of clear, soft, homogeneous protoplasm which lies over the surface of the naked cells lining the cavity, and which I now regard as the "Hautschicht" or cortical layer of these cells. I then suggested that the function of these

wise regarded than as an expression of an early differentiation in the structure of the cell, and not, as has been maintained, an ultimate or "plastidular" ondition of protoplasm

[1] The Red Snow Plant (*Protococcus nivalis*) acts on the atmosphere through the agency of chlorophyll, like the ordinary green plants. As in these, chlorophyll is developed in it, and is only withdrawn from view by the predominant red pigment to which the *Protococcus* owes one of its most striking characteristics.

[2] "On the Structure and Development of *Myriothela*," *Phil. Trans.*, vol. clxv., 1875, p. 552.

[3] *Jenaische Zeitschr.*, 1871.

[4] "Die Embryonanlage und erste Entwickelung des Flusskrebse," *Zeitschr. f. wissens. Zoologie*, 1877.

[5] *Loc. cit.*

pseudopodia lay in seizing, in the manner of an *Amœba*, such alimentary matter as may be found in the contents of the canal, and applying it to the nutrition of the hydroid.

What I had thus suggested with regard to *Myriothela* has been since proved in certain planarian worms by Metschnikoff,[1] who has seen the cells which line the alimentary canal in these animals act like independent *Amœbæ*, and engulph in their protoplasm such solid nutriment as may be contained in the canal. When the planaria was fed with colouring matter these amœboid cells became gorged with the coloured particles just as would have happened in an *Amœba* when similarly fed.

But it is not alone in such loosely aggregated cells as those of the blood, or in the amœboid cells of the alimentary canal, or in such scattered constituents of the tissues as the pigment cells, or in cells destined for an ultimate state of freedom, as the egg, that there exists an independence. The whole complex organism is a society of cells, in which every individual cell possesses an independence, an autonomy, not at once so obvious as in the blood cells, but not the less real. With this autonomy of each element there is at the same time a subordination of each to the whole, thus establishing a unity in the entire organism, and a concert and harmony between all the phenomena of its life.

In this society of cells each has its own work to perform, and the life of the organism is made up of the lives of its component cells. Here it is that we find most distinctly expressed the great law of the physiological division of labour. In the lowest organisms, where the whole being consists of a single cell, the performance of all the processes which constitute its life must devolve on the protoplasm of this one cell; but as we pass to more highly organised beings, the work becomes distributed among a multitude of workers. These workers are the cells which now make up the complex organism. The distribution of labour, however, is not a uniform one, and we are not to suppose that the work performed by each cell is but a repetition of that of every other. For the life processes, which are accumulated in the single cell of the unicellular organism become in the more complex organism differentiated, some being intensified and otherwise modified and allocated to special cells, or to special groups of cells, which we call organs, and whose proper duty is now to take charge of the special processes which have been assigned to them. In all this we have a true division of labour —a division of labour, however, by no means absolute; for the processes which are essential to the life of the cell must still continue common to all the cells of the organism. No cell, however great may be the differentiation of function in the organism, can dispense with its irritability, the one constant and essential property of every living cell. There thus devolves on each cell or group of cells some special work which contributes to the well-being of all, and their combined labours secure the necessary conditions of life for every cell in the community, and result in those complex and wonderful phenomena which constitute the life of the higher organisms.

We have hitherto considered the cell only as a mass of active nucleated protoplasm, either absolutely naked, or partially inclosed in a protective case, which still permits free contact of the protoplasm with the surrounding medium. In very many instances, however, the protoplasm becomes confined within resisting walls, which entirely shut it in from all direct contact with the medium which surrounds it. With the plant this is almost always so after the earliest stages of its life. Here the protoplasm of the cells is endowed with the faculty of secreting over its surface a firm, resisting membrane, composed of cellulose, a substance destitute of nitrogen, thus totally different from the contained protoplasm, and incapable of manifesting any of the phenomena of life.

Within the walls of cellulose the protoplasm is now closely imprisoned, but we are not on that account to suppose that it has lost its activity, or has abandoned its work as a living being. Though it is now no longer in direct contact with the surrounding medium, it is not the less dependent on it, and the reaction between the imprisoned protoplasm and the outer world is still permitted by the permeability of the surrounding wall of cellulose.

When the protoplasm thus becomes surrounded by a cellulose wall it seldom retains the uniform arrangement of its parts which is often found in the naked cells. Minute cavities or vacuoles make their appearance in it; these increase in size and run one into the other, and may finally form one large cavity in the centre, which becomes filled with a watery fluid, known as the Cell Sap. This condition of the cell was the first observed, and it was it which suggested the often inapplicable term "cell." By the formation of this central sap cavity the surrounding protoplasm is pushed aside, and pressed against the cellulose wall, over which it now extends as a continuous layer. The nucleus either continues near the centre, enveloped by a layer of protoplasm, which is connected by radiating bands of protoplasm with that of the walls, or it accompanies the displaced protoplasm, and lies embedded in this on the walls of the cell.

We have abundant evidence to show that the imprisoned protoplasm loses none of its activity. The *Characeæ* constitute an exceedingly interesting group of simple plants, common in the clear water of ponds and of slowly-running streams. The cells of which they are built up are comparatively large, and, like almost all vegetable cells, are each inclosed in a wall of cellulose. The cellulose is perfectly transparent, and if the microscope, even with a low power, be brought to bear on one of these cells, a portion of its protoplasm may be seen in active rotation, flowing up one side of the long tubular cell and down the other, and sweeping on with it such more solid particles as may become enveloped in its current. In another water plant, the *Valisneria spiralis*, a similar active rotation of the protoplasm may be seen in the cells of the leaf, where the continuous stream of liquid protoplasm sweeping along the green granules of chlorophyll, and even carrying the globular nucleus with it in its current, presents one of the most beautiful of the many beautiful phenomena which the microscope has revealed to us.

In many other cells with large sap cavities, such as those which form the stinging hairs of nettles and other kinds of vegetable hairs, the protoplasmic lining of the wall may send off into the sap cavity projecting ridges and strings, forming an irregular network, along which, under a high power of the microscope, a slow streaming of granules may be witnessed. The form and position of this protoplasmic network undergo constant changes, and the analogy with the changes of form in an *Amœba* becomes obvious. The external wall of cellulose renders it impossible for the confined protoplasm to emit, like a naked *Amœba*, pseudopodia from its outer side; but on the inner side there is no obstacle to the extension of the protoplasm, and here the cavity of the cell becomes more or less completely traversed by protoplasmic projections from the wall. These often stretch themselves out in the form of thin filaments, which, meeting with a neighbouring one, become fused into it; they show currents of granules streaming along their length, and after a time become withdrawn and disappear. The vegetable cell, in short, with its surrounding wall of cellulose, is in all essential points a closely imprisoned Rhizopod.

Further proof that the imprisoned protoplasm has lost by its imprisonment none of its essential irritability, is afforded by the fact that if the transparent cell of a Nitella, one of the simple water plants just referred to, be touched under the microscope with the point of a blunt needle, its green protoplasm will be seen to recede, under the irritation of the needle, from the cellulose wall. If the cellulose wall of the comparatively large cell which forms the entire plant in a Vaucheria, a unicellular alga, very common in shallow ditches, be ruptured under the microscope, its protoplasm will escape, and may then be often seen to throw out pseudopodial projections and exhibit amœboid movements.

Even in the higher plants, without adducing such obvious and well-known instances as those of the Sensitive Plant and Venus's Flytrap, the irritability of the protoplasm may be easily rendered manifest. There are many herbaceous plants in which if the young succulent stem of a vigorously growing specimen receive a sharp blow, of such a nature, however, as not to bruise its tissues, or in any way wound it, the blow will sometimes be immediately followed by a drooping of the stem commencing at some distance above the point to which the stroke had been applied; its strength appears to have here suddenly left it, it is no longer able to bear its own weight, and seems to be dying. The protoplasm, however, of its cells, is in this instance not killed, it is only stunned by the violence of the blow, and needs time for its restoration. After remaining, it may be for some hours, in this drooping and flaccid state, the stem begins to raise itself, and soon regains its original vigour. This experiment will generally succeed well in plants with a rather large terminal spike or raceme when the stroke is applied some little distance below the inflorescence shortly before the expansion of the flower.

[1] "Ueber die Verdauungsorgane einiger Süsswasser-Turbellarien," *Zoologischer Anzeiger*, December, 1878.

In the several instances now adduced the protoplasm is in the mature state of the plant entirely included within a wall of cellulose. Some recent beautiful observations, however, of Mr. Francis Darwin have shown that even in the higher plants truly naked protoplasm may occur. From the cells of certain glandular hairs contained within the cup-like receptacles formed by the united bases of two opposite leaves in the Teazel (*Dipsacus*) he has seen emitted long pseudopodia-like projections of the protoplasm. What may be the significance of this very exceptional phenomenon is still undetermined. It is probably as Mr. Darwin supposes connected with the absorption of nitrogenous matter.

That there is no essential difference between the protoplasm of plants and that of animals is rendered further evident by other motor phenomena, which we are in the habit of regarding as the exclusive attribute of animals. Many of the more simply organised plants give origin to peculiar cells called spores, which separate from the parent, and, like the seeds of the higher plants, are destined to repeat its form. In many cases these spores are eminently locomotive. They are then termed "swarm-spores," and their movements are brought about, sometimes by changes of shape, when they move about in the manner of an *Amœba*, but more frequently by minute vibratile cilia, or by more strongly developed flagella or whip-like projections of their protoplasm. These cilia and flagella are absolutely indistinguishable from similar structures widely distributed among animals, and by their vibratory or lashing strokes upon the surrounding water the swarm-spores are rapidly carried from place to place. In these motions they often present a curious semblance of volition, for if the swarm-spore meet with an obstacle in its course, it will, as if to avoid it, change the direction of its motion, and retreat by a reversion of the stroke of its cilia. They are usually attracted by light, and congregate at the light side of the vessel which contains them, though in some cases light has the opposite effect on them, and they recede from it.

Another fact may here be adduced to show the uniform character of protoplasm and how very different are its properties from those of lifeless matter, namely, the faculty which all living protoplasm possesses of resisting the entrance of colouring matter into its substance. As many here present are aware, microscopists are in the habit of using in their investigations various colouring matters, such as solutions of carmine. These act differently on the different tissues, staining some, for example, more deeply than others, and thus enabling the histologist to detect certain elements of structure, which would otherwise remain unknown. Now if a solution of carmine be brought into contact with living protoplasm, this will remain, so long as it continues alive, unaffected by the colouring matter. But if the protoplasm be killed, the carmine will at once pervade its whole substance, and stain it throughout with a colour more intense than even that of the colouring solution itself.

But no more illustrative example can be offered of the properties of protoplasm as living matter, independently of any part it may take in organisation, than that presented by the Myxomycetæ.

The Myxomycetæ constitute a group of remarkable organisms, which, from their comparatively large size and their consisting, during a great part of their lives, of naked protoplasm, have afforded a fine field for research, and have become one of the chief sources from which our knowledge of the nature and phenomena of protoplasm has been derived.

They have generally been associated by botanists with the fungi, but though their affinities with these are perhaps closer than with any other plants, they differ from them in so many points, especially in their development, as to render this association untenable. They are found in moist situations, growing on old tan or on moss, or decaying leaves or rotten wood, over which they spread in the form of a network of naked protoplasmic filaments, of a soft creamy consistence, and usually of a yellowish colour.

Under the microscope the filaments of the network exhibit active spontaneous movements, which, in the larger branches, are visible under an ordinary lens, or even by the naked eye. A succession of undulations may then be noticed passing along the course of the threads. Under higher magnifying powers a constant movement of granules may be seen flowing along the threads, and streaming from branch to branch of this wonderful network. Here and there off-shoots of the protoplasm are projected, and again withdrawn in the manner of the pseudopodia of an *Amœba*, while the whole organism may be occasionally seen to abandon the support over which it had grown, and to creep over neighbouring surfaces, thus far resembling in all respects a colossal ramified *Amœba*. It is also curiously sensitive to light, and may be sometimes found to have retreated during the day to the dark side of the leaves, or into the recesses of the tan over which it had been growing, and again to creep out on the approach of night.

After a time there arise from the surface of this protoplasmic net oval capsules or spore cases, in which are contained the spores or reproductive bodies of the Myxomycetæ. When the spore-case has arrived at maturity, it bursts and allows the spores to escape. These are in the form of spherical cells, each included in a delicate membranous wall, and when they fall into water the wall becomes ruptured, and the little cell creeps out. This consists of a little mass of protoplasm with a round central nucleus, inclosing a nucleolus, and with a clear vacuole, which exhibits a rhythmically pulsating movement. The little naked spore thus set at liberty is soon seen to be drawn out at one point into a long vibratile whip-like flagellum, which by its lashing action carries the spore from place to place. After a time the flagellum disappears, and the spore may now be seen emitting and withdrawing finger-like pseudopodia, by means of which it creeps about like an *Amœba*, and like an *Amœba* devours solid particles by engulfing them in its soft protoplasm.

So far these young *Amœba*-like Myxomycetæ have enjoyed each an independent existence. Now, however, a singular and significant phenomenon is presented. Two or more of these Myxamœbæ, as they have been called, approach one another, come into contact, and finally become completely fused together into a single mass of protoplasm, in which the components are no longer to be distinguished. To the body thus formed by the fusion of the Myxamœbæ the name of "plasmodium" has been given.

The plasmodium continues, like the simple amœbiform bodies of which it is composed, to grow by the ingestion and assimilation of solid nutriment, which it envelopes in its substance; it throws out ramifying and mosculating processes, and finally becomes converted into a protoplasmic network, which in its turn gives rise to spore-cases with their contained spores, and thus completes the cycle of its development.

Under certain external conditions, the Myxomycetæ have been observed to pass from an active mobile state into a resting state, and this may occur both in the amœbiform spores and in the plasmodium. When the plasmodium is about to pass into a resting state, it usually withdraws its finer branches, and expels such solid ingesta as may be included in it. Its motions then gradually cease, it breaks up into a multitude of polyhedral cells, which, however, remain connected, and the whole body dries into a horny brittle mass, known by the name of "sclerotium."

In this condition, without giving the slightest sign of life, the sclerotium may remain for many months. Life, however, is not destroyed, its manifestations are only suspended, and if after an indefinite time the apparently dead sclerotium be placed in water, it immediately begins to swell up, the membranous covering of its component cells becomes dissolved and disappears, and the cells themselves flow together into an active amœboid plasmodium.

We have already seen that every cell posseses an autonomy or independent individuality, and from this we should expect that, like all living beings it had the faculty of multiplying itself, and of becoming the parent of other cells. This is truly the case, and the process of cell-multiplication has of late years been studied, with the result of adding largely to our knowledge of the phenomena of life.

The labours of Strasburger, of Auerbach, of Oscar Hertwig, of Eduard van Beneden, Bütschli, Fol, and others, here come prominently before us, but neither the time at my disposal nor the purport of this address will allow me to do more than call your attention to some of the more striking results of their investigations.

By far the most frequent mode of multiplication among cells shows itself in a spontaneous division of the protoplasm into two separate portions, which then become independent of one another, so that instead of the single parent cell two new ones have made their appearance. In this process the nucleus usually takes an important part. Strasburger has studied it with great care in certain plant cells, such as the so-called "corpuscula" or "secondary embryo-sacs" of the Coniferæ and the cells of Spirogyra; and has further shown a close correspondence between cell division in animals and that in plants.

It may be generally stated as the results of his observations on the corpuscula of the Coniferæ, that the nucleus of the cell about to divide assumes a spindle shape, and at the same time presents a peculiar striated differentiation, as if it were composed of parallel filaments reaching from end to end of the spindle. These filaments become thickened in the middle, and there form by the approximation of the thickened portions a transverse plate of protoplasm (the "nucleus-plate"). This soon splits into two halves, which recede from one another towards the poles of the spindle, travelling in this course along the filaments, which remain continuous from end to end. When arrived near the poles they form there two new nuclei, still connected with one another by the intervening portion of the spindle.

In the equator of this intervening portion there is now formed in a similar way a second plate of protoplasm (the "cell-plate"), which, extending to the walls of the dividing cell, cuts the whole protoplasm into two halves, each half containing one of the newly-formed nuclei. This partition plate is at first single, but it soon splits into two laminæ, which become the apposed bounding surfaces of the two protoplasm masses into which the mother cell has been divided. A wall of cellulose is then all at once secerted between them, and the two daughter cells are complete.

It sometimes happens in the generation of cells that a young brood of cells arises from the parent cell by what is called "free cell formation." In this only a part of the protoplasm of the mother cell is used up in the production of the offspring. It is seen chiefly in the formation of the spores of the lower plants, in the first foundation of the embryo in the higher, and in the formation of the endosperm—a cellular mass which serves as the first nutriment for the embryo—in the seeds of most Phanerogams. The formation of the endosperm has been carefully studied by Strasburger in the embyro-sac of the kidney bean, and may serve as an example of the process of free cell formation. The embryo-sac is morphologically a large cell with its protoplasm, nucleus, and cellulose wall, while the endosperm which arises within it is composed of a multitude of minute cells united into a tissue. The formation of the endosperm is preceded by the dissolution and disappearance of the nucleus of the embryo-sac, and then in the midst of the protoplasm of the sac several new nuclei make their appearance. Around each of these as a centre the protoplasm of the mother cell is seen to have become differentiated in the form of a clear spherule, and we have thus corresponding to each of the new nuclei a young naked cell, which soon secretes over its surface a membrane of cellulose. The new cells, when once formed, multiply by division, press one on the other, and so combining into a cellular mass, constitute the completed endosperm.

Related to the formation of new cells, whether by division or by free cell formation, is another very interesting phenomenon of living protoplasm known as "rejuvenescence." In this the whole protoplasm of a cell, by a new arrangement of its parts, assumes a new shape and acquires new properties. It then abandons its cellulose chamber, and enters on a new and independent life in the surrounding medium.

A good example of this is afforded by the formation of swarm-spores in Œdogonium, one of the fresh-water algæ. Here the whole of the protoplasm of an adult cell contracts, and by the expulsion of its cell-sap changes from a cylindrical to a globular shape. Then one spot becomes clear, and a pencil of vibratile cilia here shows itself. The cellulose wall which had hitherto confined it now becomes ruptured, and the protoplasmic sphere, endowed with new faculties of development and with powers of active locomotion, escapes as a swarm-spore, which, after enjoying for a time the free life of an animal, comes to rest, and develops itself into a new plant.

The beautiful researches which have within the last few years been made by the observers already mentioned, on the division of animal cells, show how close is the agreement between plants and animals in all the leading phenomena of cell division, and afford one more proof of the essential unity of the two great organic kingdoms.

There is one form of cell which, in its relation to the organic world, possesses a significance beyond that of every other, namely, the egg. As already stated, the egg is, wherever it occurs, a typical cell, consisting essentially of a globule of protoplasm enveloping a nucleus (the "germinal vesicle"), and with one or more nucleoli (the "germinal spots") in the interior of the nucleus. This cell, distinguishable by no tangible characters from thousands of other cells, is nevertheless destined to run through a definite series of developmental changes, which have as their end the building up of an organism like that to which the egg owes its origin.

It is obvious that such complex organisms as thus result—composed, it may be, of countless millions of cells—can be derived from the simple egg cell only by a process of cell multiplication. The birth of new cells derived from the primary cell or egg thus lies as the basis of embryonic development. It is here that the phenomena of cell multiplication in the animal kingdom can in general be most satisfactorily observed, and the greater number of recent researches into the nature of these phenomena have found their most fertile field in the early periods of the development of the egg.

A discussion of the still earlier changes which the egg undergoes in order to bring it into the condition in which cell multiplication may be possible, would, however full of interest, be here out of place; and I shall therefore confine myself to the first moments of actual development—to what is called "the cleavage of the egg"—which is nothing more than a multiplication of the egg cell by repeated division. I shall further confine myself to an account of this phenomenon as presented in typical cases, leaving out of consideration certain modifications which would only complicate and obscure our picture.

The egg, notwithstanding the preliminary changes to which I have alluded, is still at the commencement of development, a true cell. It has its protoplasm and its nucleus, and it is, as a rule, enveloped in a delicate membrane. The protoplasm forms what is known as the vitellus, or yolk, and the surrounding membrane is callled the "vitellary membrane." The division which is now about to take place in it is introduced by a change of form in the nucleus. This becomes elongated, and assumes the shape of a spindle, similar to what we have already seen in the cell-division of plants. On each pole of the spindle transparent protoplasm collects, forming here a clear spherical area.

At this time a very striking and characteristic phenomenon is witnessed in the egg. Each pole of the spindle has become the centre of a system of rays which stream out in all directions into the surrounding protoplasm. The protoplasm thus shows, enveloped in its mass, two sun-like figures, whose centres are connected to one another by the spindle-shaped nucleus. To this, with the sun-like rays streaming from its poles, Auerbach gives the name of "Karyolitic figure," suggested by its connection with the breaking up of the original nucleus, to which our attention must next be directed.

A phenomenon similar to one we have already seen in cell-division among plants now shows itself. The nucleus becomes broken up into a number of filaments, which lie together in a bundle, each filament stretching from pole to pole of the spindle. Exactly in its central point every filament shows a knot-like enlargement, and from the close approximation of the knots there results a thick zone of protoplasm in the equator of the spindle. Each knot soon divides into two halves, and each half recedes from the equator and travels along the filament towards its extremity. When arrived at the poles of the spindle each set of half knots becomes fused together into a globular body, while the intervening portion of the spindle, becoming torn up, and gradually drawn into the substance of the two globular masses, finally disappears. And now, instead of the single fusiform nucleus whose changes we have been tracing, we have two new globular nuclei, each occupying the place of one of its poles, and formed at its expense.[1] The egg now begins to divide along

[1] Though none of the above-mentioned observers to whom we owe our knowledge of the phenomena here described seem to have thought of connecting the fibrous condition assumed by the spindle with any special structure of the quiescent nucleus, it is highly probable that it consists in a rearrangement of fibres already present. That this is really the case is borne out by the observations of Schleicher on the division of cartilage cells. ("Die Knorpelzelltheilung," *Arch. für mikr. Anat.*, Band xvi. Heft 2, 1878.) From these it would appear that in the division of cartilage cells the investing membrane of the nucleus first becomes torn up, and then the filaments, rodlets, and granules, which, according to him, form its body, enter into a state of intense motor activity, and may be seen arranging themselves into star-like, or wreath-like, or irregular figures, while the whole nucleus, now deprived of its membrane, may wander about the cell, travelling towards one of its poles, and then towards the other; or it may at one time contract, and then again dilate, to such an extent as nearly to fill the entire cell. To this nuclear activity Schleicher applies the term "Karyokinesis." It results in a nearly parallel arrangement of the nuclear filaments. Then these converge at their extremities and become more widely separated in the middle, so as to give to the nucleus the form of a spindle. The filaments then become fused together at each pole of the spindle, so as to form the two new nuclei, which are at first nearly homogeneous, but which afterwards become broken up into their component filaments, rods, and granules.

a plane at right angles to a line connecting the two nuclei. The division takes place without the formation of a cell plate such as we saw in the division of the plant cell, and is introduced by a constriction of its protoplasm, which commences at the circumference just within the vitelline membrane, and extending towards the centre, divides the whole mass of protoplasm into two halves, each including within it one of the new nuclei. Thus the simple cell which constituted the condition of the egg at the commencement of development becomes divided into two similar cells. This forms the first stage of cleavage. Each of these two young cells divides in its turn in a direction at right angles to the first division-plane, while by continued repetition of the same act the whole of the protoplasm or yolk becomes broken up into a vast multitude of cells, and the unicellular organism—the egg, with which we began our history—has become converted into an organism composed of many thousands of cells. This is one of the most widely distributed phenomena of the organic world. It is called "the cleavage of the egg," and consists essentially in the production, by division, of successive broods of cells from a single ancestral cell—the egg.

It is no part of my purpose to carry on the phenomena of development further than this. Such of my hearers as may desire to become acquainted with the further history of the embryo, I would refer to the excellent address delivered two years ago at the Plymouth meeting of the Association by one of my predecessors in this chair—Prof. Allen Thompson.

That protoplasm, however, may present a phenomenon the reverse of that in which a simple cell becomes multiplied into many, is shown by a phenomenon already referred to—the production of plasmodia in the Myxomycetæ by the fusion into one another of cells originally distinct.

The genus *Myriothela* will afford another example in which the formation of plasmodia becomes introduced into the cycle of development. The primitive eggs are here, as elsewhere, true cells with nucleolated nuclei, but without any boundary membrane. They are formed in considerable numbers, but remain only for a short time separate and distinct. After this they begin to exhibit amœboid changes of shape, project pseudopodial prolongations which coalesce with those of others in their vicinity, and finally a multitude of these primitive ova become fused together into a common plasmodium, in which, as in the simple egg cell of other animals, the phenomena of development take place.

In many of the lower plants a very similar coalescence is known to take place between the protoplasmic bodies of separate cells, and constitutes the phenomenon of conjugation. *Spirogyra* is a genus of Algæ, consisting of long green threads common in ponds. Every thread is composed of a series of cylindrical chambers of transparent cellulose placed end to end, each containing a sac of protoplasm with a large quantity of cell sap, and with a green band of chlorophyll wound spirally on its walls. When the threads have attained their full growth they approach one another in pairs, and lie in close proximity, parallel one to the other. A communication is then established by means of short connecting tubes between the chambers of adjacent filaments, and across the channel thus formed the whole of the protoplasm of one of the conjugating chambers passes into the cavity of the other, and then immediately fuses with the protoplasm it finds there. The single mass thus formed shapes itself into a solid oval body, known as a "zygospore." This now frees itself from the filament, secretes over its naked surface a new wall of cellulose, and, when placed in the conditions necessary for its development, attaches itself by one end, and then, by repeated acts of cell division, grows into a many-celled filament like those in which it originated.

The formation of plasmodia, regarded as a coalescence and absolute fusion into one another of separate naked masses of protoplasm, is a phenomenon of great significance. It is highly probable that, notwithstanding the complete loss of individuality in the combining elements, such differences as may have been present in these will always find itself expressed in the properties of the resulting plasmodia—a fact of great importance in its bearing on the phenomena of inheritance. Recent researches, indeed, render it almost certain that fertilisation, whether in the animal or the vegetable kingdom, consists essentially in the coalescence and consequent loss of individuality of the protoplasmic contents of two cells.

In by far the greater number of plants the protoplasm of most of the cells which are exposed to the sunlight undergoes a curious and important differentiation, part of it becoming separated from the remainder in the form usually of green granules, known as chlorophyll granules. The chlorophyll granules thus consist of true protoplasm, their colour being due to the presence of a green colouring matter, which may be extracted, leaving behind the colourless protoplasmic base.

The colouring matter of chlorophyll presents under the spectroscope a very characteristic spectrum. For our knowledge of its optical properties, on which time will not now permit me to dwell, we are mainly indebted to the researches of your townsman, Dr. Sorby, who has made these the subject of a series of elaborate investigations, which have contributed largely to the advancement of an important department of physical science.

That the chlorophyll is a living substance, like the uncoloured protoplasm of the cell, is sufficiently obvious. When once formed, the chlorophyll granule may grow by intussusception of nutriment to many times its original size, and may multiply itself by division.

To the presence of chlorophyll is due one of the most striking aspects of external nature—the green colour of the vegetation which clothes the surface of the earth; and with its formation is introduced a function of fundamental importance in the economy of plants, for it is on the cells which contain this substance that devolves the faculty of decomposing carbonic acid. On this depends the assimilation of plants, a process which becomes manifest externally by the exhalation of oxygen. Now it is under the influence of light on the chlorophyll-containing cells that this evolution of oxygen is brought about. The recent observations of Draper and of Pfeffer have shown that in this action the solar spectrum is not equally effective in all its parts; that the yellow and least refrangible rays are those which act with most intensity; that the violet and other highly refrangible rays of the visible spectrum take but a very subordinate part in assimilation; and that the invisible rays which lie beyond the violet are totally inoperative.

In almost every grain of chlorophyll one or more starch granules may be seen. This starch is chemically isomeric with the cellulose cell wall, with woody fibre, and other hard parts of plants, and is one of the most important products of assimilation. When plants whose chlorophyll contains starch are left for a sufficient time in darkness, the starch is absorbed and completely disappears; but when they are restored to the light the starch reappears in the chlorophyll of the cells.

With this dependence of assimilation on the presence of chlorophyll a new physiological division of labour is introduced into the life of plants. In the higher plants, while the work of assimilation is allocated to the chlorophyll-containing cells, that of cell division and growth devolves on another set of cells, which, lying deeper in the plant, are removed from the direct action of light, and in which chlorophyll is therefore never produced. In certain lower plants, in consequence of their simplicity of structure and the fact that all the cells are equally exposed to the influence of light, this physiological division of labour shows itself in a somewhat different fashion. Thus in some of the simple green algæ, such as *Spirogyra* and *Hydrodictyon*, assimilation takes place as in other cases during the day, while their cell division and growth takes place chiefly, if not exclusively, at night. Strasburger, in his remarkable observations on cell divisions in *Spirogyra*, was obliged to adopt an artificial device in order to compel the *Spirogyra* to postpone the division of its cells to the morning.

Here the functions of assimilation and growth devolve on one and the same cell, but while one of these functions is exercised only during the day, the time for the other is the night. It seems impossible for the same cell at the same time to exercise both functions, and these are here accordingly divided between different periods of the twenty-four hours.

The action of chlorophyll in bringing about the decomposition of carbonic acid is not, as was recently believed, absolutely confined to plants. In some of the lower animals, such as *Stentor* and other infusoria, the Green Hydra, and certain green planariæ and other worms, chlorophyll is differentiated in their protoplasm, and probably always acts here under the influence of light exactly as in plants.

Indeed, it has been proved[1] by some recent researches of Mr. Geddes, that the green planarias when placed in water and exposed to the sunlight give out bubbles of gas which contain from 44 to 55 per cent. of oxygen. Mr. Geddes has further shown that these animals contain granules of starch in their tissues, and

[1] "Sur la Fonction de la Chlorophyll dans les Planaires vertes," *Comptes Rendus*, December, 1878.

in this fact we have another striking point of resemblance between them and plants.

A similar approximation of the two organic kingdoms has been shown by the beautiful researches of Mr. Darwin—confirmed and extended by his son, Mr. Francis Darwin—on Drosera and other so-called carnivorous plants. These researches, as is now well known, have shown that in all carnivorous plants there is a mechanism fitted for the capture of living prey, and that the animal matter of the prey is absorbed by the plant after having been digested by a secretion which acts like the gastric juice of animals.

Again, Nägeli has recently shown [1] that the cell of the yeast fungus contains about 2 per cent. of peptine, a substance hitherto known only as a product of the digestion of azotised matter by animals.

Indeed, all recent research has been bringing out in a more and more decisive manner the fact that there is no dualism in life,—that the life of the animal and the life of the plant are, like their protoplasm, in all essential points identical.

But there is, perhaps, nothing which shows more strikingly the identity of the protoplasm in plants and animals, and the absence of any deep-pervading difference between the life of the animal and that of the plant, than the fact that plants may be placed, just like animals, under the influence of anæsthetics.

When the vapour of chloroform or of ether is inhaled by the human subject, it passes into the lungs, where it is absorbed by the blood, and thence carried by the circulation to all the tissues of the body. The first to be affected by it is the delicate nervous element of the brain, and loss of consciousness is the result. If the action of the anæsthetic be continued, all the other tissues are in their turn attacked by it and their irritability arrested. A set of phenomena entirely parallel to these may be presented by plants.

We owe to Claude Bernard a series of interesting and most instructive experiments on the action of ether and chloroform on plants. He exposed to the vapour of ether a healthy and vigorous sensitive plant, by confining it under a bell-glass into which he introduced a sponge filled with ether. At the end of half an hour the plant was in a state of anæsthesia, all its leaflets remained fully extended, but they showed no tendency to shrink when touched. It was then withdrawn from the influence of the ether, when it gradually recovered its irritability, and finally responded, as before, to the touch.

It is obvious that the irritability of the protoplasm was here arrested by the anæsthetic, so that the plant became unable to give a response to the action of an external stimulus.

It is not, however, the irritability of the protoplasm of only the motor elements of plants that anæsthetics are capable of arresting. These may act also on the protoplasm of those cells whose function lies in chemical synthesis, such as is manifestsd in the phenomena of the germination of the seed and in nutrition generally, and Claude Bernard has shown that germination is suspended by the action of ether or chloroform.

Seeds of cress, a plant whose germination is very rapid, were placed in conditions favourable to a speedy germination, and while thus placed were exposed to the vapour of ether. The germination, which would otherwise have shown itself by the next day, was arrested. For five or six days the seeds were kept under the influence of the ether, and showed during this time no disposition to germinate. They were not killed, however, they only slept, for on the substitution of common air for the etherised air with which they had been surrounded, germination at once set in and proceeded with activity.

Experiments were also made on that function of plants by which they absorb carbonic acid and exhale oxygen, and which, as we have already seen, is carried on through the agency of the green protoplasm or chlorophyll, under the influence of light—a function which is commonly, but erroneously, called the respiration of plants.

Aquatic plants afford the most convenient subjects for such experiments. If one of these be placed in a jar of water holding ether or chloroform in solution, and a bell-glass be placed over the submerged plant, we shall find that the plant no longer absorbs carbonic acid or emits oxygen. It remains, however, quite green and healthy. In order to awaken the plant, it is only necessary to place it in non-etherised water, when it will begin once more to absorb carbonic acid, and exhale oxygen under the influence of sunlight.

[1] "Ueber die chemische Zusammensetzung der Hefe," *Sitzungsbericht der math. phys. Classe der k.k. Akad. der Wissens. zu München*, 1878.

The same great physiologist has also investigated the action of anæsthetics on fermentation. It is well known that alcoholic fermentation is due to the presence of a minute fungus, the yeast fungus, the living protoplasm of whose cells has the property of separating solutions of sugar into alcohol, which remains in the liquid, and carbonic acid, which escapes into the air.

Now, if the yeast plant be placed along with sugar in etherised water it will no longer act as a ferment. It is anæsthesiated, and cannot respond to the stimulus which, under ordinary circumstances, it would find in the presence of the sugar. If, now, it be placed on a filter, and the ether washed completely away, it will, on restoration to a saccharine liquid, soon resume its duty of separating the sugar into alcohol and carbonic acid.

Claude Bernard has further called attention to a very significant fact which is observable in this experiment. While the proper alcoholic fermentation is entirely arrested by the etherisation of the yeast plant, there still goes on in the saccharine solution a curious chemical change, the cane sugar of the solution being converted into grape sugar, a substance identical in its chemical composition with the cane sugar, but different in its molecular constitution. Now it is well known from the researches of Bertholet that this conversion of cane sugar into grape sugar is due to a peculiar inversive ferment, which, while it accompanies the living yeast plant, is itself soluble and destitute of life. Indeed it has been shown that in its natural conditions the yeast fungus is unable of itself to assimilate cane sugar, and that in order that this may be brought into a state fitted for the nutrition of the fungus, it must be first digested and converted into grape sugar, exactly as happens in our own digestive organs. To quote Claude Bernard's graphic account:—

"The fungus ferment has thus beside it in the same yeast a sort of servant given by nature to effect this digestion. The servant is the unorganised inversive ferment. This ferment is soluble, and as it is not a plant, but an unorganised body destitute of sensibility, it has not gone to sleep under the action of the ether, and thus continues to fulfil its task."

In the experiment already recorded on the germination of seeds the interest is by no means confined to that which attaches itself to the arrest of the organising functions of the seed, those namely which manifest themselves in the development of the radicle and plumule and other organs of the young plant. Another phenomenon of great significance becomes at the same time apparent—the anæsthetic exerts no action on the concomitant chemical phenomena which in germinating seeds show themselves in the transformation of starch into sugar under the influence of diastase (a soluble and non-living ferment which also exists in the seed), and the absorption of oxygen with the exhalation of carbonic acid. These go on as usual, the anæsthesiated seed continuing to respire, as proved by the accumulation of carbonic acid in the surrounding air. The presence of the carbonic acid was rendered evident by placing in the same vessel with the seeds which were the object of the experiment, a solution of barytes, when the carbonate became precipitated from the solution in quantity equal to that produced in a similar experiment with seeds germinating in unetherised air.

So, also in the experiment which proves the faculty possessed by the chlorophyllian cells of absorbing carbonic acid and exhaling oxygen under the influence of light may be arrested by anæsthetics, it could be seen that the plant, while in a state of anæsthesia, continued to respire in the manner of animals; that is, it continued to absorb oxygen and exhale carbonic acid. This is the true respiratory function which was previously masked by the predominant function of assimilation, which devolves on the green cells of plants, and which manifests itself under the influence of light in the absorption of carbonic acid and the exhalation of oxygen.

It must not, however, be supposed that the respiration of plants is entirely independent of life. The conditions which bring the oxygen of the air and the combustible matter of the respiring plant into such relations as may allow them to act on one another are still under its control, and we must conclude that in Claude Bernard's experiment the anæsthesia had not been carried so far as to arrest such properties of the living tissues as are needed for this.

The quite recent researches of Schützenberger, who has investigated the process of respiration as it takes place in the cell of the yeast fungus, have shown that vitality is a factor in this process. He has shown that fresh yeast, placed in water, breathes like an aquatic animal, disengaging carbonic acid, and causing

the oxygen contained in the water to disappear. That this phenomenon is a function of the living cell is proved by the fact that, if the yeast be first heated to 60° C. and then placed in the oxygenated water, the quantity of oxygen in the water remains unchanged; in other words, the yeast ceases to breathe.

Schützenberger has further shown that light exerts no influence on the respiration of the yeast cell—that the absorption of oxygen by the cell takes place in the dark exactly as in sunlight. On the other hand, the influence of temperature is well marked. Respiration is almost entirely arrested at temperatures below 10° C., it reaches its maximum at about 40° C., while at 60° C. it again ceases.

All this proves that the respiration of living beings is identical, whether manifested in the plant or in the animal. It is essentially a destructive phenomenon—as much so as the burning of a piece of charcoal in the open air, and, like it, is characterised by the disappearance of oxygen and the formation of carbonic acid.

One of the most valuable results of the recent careful application of the experimental method of research to the life phenomena of plants is thus the complete demolition of the supposed antagonism between respiration in plants and that in animals.

I have thus endeavoured to give you in a few broad outlines a sketch of the nature and properties of one special modification of matter, which will yield to none other in the interest which attaches to its study, and in the importance of the part allocated to it in the economy of nature. Did the occasion permit I might have entered into many details which I have left untouched; but enough has been said to convince you that in protoplasm we find the only form of matter in which life can manifest itself; and that, though the outer conditions of life—heat, air, water, food—may all be present, protoplasm would still be needed, in order that these conditions may be utilised, in order that the energy of lifeless nature may be converted into that of the countless multitudes of animal and vegetable forms which dwell upon the surface of the earth or people the great depths of its seas.

We are thus led to the conception of an essential unity in the two great kingdoms of organic Nature—a structural unity, in the fact that every living being has protoplasm as the essential matter of every living element of its structure; and a physiological unity, in the universal attribute of irritability which has its seat in this same protoplasm, and is the prime mover of every phenomenon of life.

We have seen how little mere form has to do with the essential properties of protoplasm. This may shape itself into cells, and the cells may combine into organs in ever-increasing complexity, and protoplasm force may be thus intensified, and, by the mechanism of organisation, turned to the best possible account; but we must still go back to protoplasm as a naked formless plasma if we would find—freed from all non-essential complications—the agent to which has been assigned the duty of building up structure and of transforming the energy of lifeless matter into that of living.

To suppose, however, that all protoplasm is identical where no difference cognisable by any means at our disposal can be detected would be an error. Of two particles of protoplasm, between which we may defy all the power of the microscope, all the resources of the laboratory, to detect a difference, one can develop only to a jelly-fish, the other only to a man, and one conclusion alone is here possible—that deep within them there must be a fundamental difference which thus determines their inevitable destiny, but of which we know nothing, and can assert nothing beyond the statement that it must depend on their hidden molecular constitution.

In the molecular condition of protoplasm there is probably as much complexity as in the disposition of organs in the most highly differentiated organisms; and between two masses of protoplasm indistinguishable from one another there may be as much molecular difference as there is between the form and arrangement of organs in the most widely separated animals or plants.

Herein lies the many-sidedness of protoplasm; herein lies its significance as the basis of all morphological expression, as the agent of all physiological work, while in all this there must be an adaptiveness to purpose as great as any claimed for the most complicated organism.

From the facts which have been now brought to your notice there is but one legitimate conclusion—that life is a property of protoplasm. In this assertion there is nothing that need startle us. The essential phenomena of living beings are not so widely separated from the phenomena of lifeless matter as to render it impossible to recognise an analogy between them; for even irritability, the one grand character of all living beings, is not more difficult to be conceived of as a property of matter than the physical phenomena of radial energy.

It is quite true that between lifeless and living matter there is a vast difference, a difference greater far than any which can be found between the most diverse manifestations of lifeless matter. Though the refined synthesis of modern chemistry may have succeeded in forming a few principles which until lately had been deemed the proper product of vitality, the fact still remains that no one has ever yet built up one particle of living matter out of lifeless elements—that every living creature, from the simplest dweller on the confines of organisation up to the highest and most complex organism, has its origin in pre-existent living matter—that the protoplasm of to-day is but the continuation of the protoplasm of other ages, handed down to us through periods of indefinable and indeterminable time.

Yet with all this, vast as the differences may be, there is nothing which precludes a comparison of the properties of living matter with those of lifeless.

When, however, we say that life is a property of protoplasm, we assert as much as we are justified in doing. Here we stand upon the boundary between life in its proper conception, as a group of phenomena having irritability as their common bond, and that other and higher group of phenomena which we designate as consciousness or thought, and which, however intimately connected with those of life, are yet essentially distinct from them.

When the heart of a recently-killed frog is separated from its body and touched with the point of a needle, it begins to beat under the excitation of the stimulus, and we believe ourselves justified in referring the contraction of the cardiac fibres to the irritability of their protoplasm as its proper cause. We see in it a remarkable phenomenon, but one nevertheless in which we can see unmistakable analogies with phenomena purely physical. There is no greater difficulty in conceiving of contractility as a property of protoplasm than there is of conceiving of attraction as a property of the magnet.

When a thought passes through the mind, it is associated, as we have now abundant reason for believing, with some change in the protoplasm of the cerebral cells. Are we, therefore, justified in regarding thought as a property of the protoplasm of these cells, in the sense in which we regard muscular contraction as a property of the protoplasm of muscle? or is it really a property residing in something far different, but which may yet need for its manifestation the activity of cerebral protoplasm?

If we could see any analogy between thought and any one of the admitted phenomena of matter, we should be justified in accepting the first of these conclusions as the simplest, and as affording a hypothesis most in accordance with the comprehensiveness of natural laws; but between thought and the physical phenomena of matter there is not only no analogy, but there is no conceivable analogy; and the obvious and continuous path which we have hitherto followed up in our reasonings from the phenomena of lifeless matter through those of living matter here comes suddenly to an end. The chasm between unconscious life and thought is deep and impassable, and no transitional phenomena can be found by which as by a bridge we may span it over; for even from irritability, to which, on a superficial view, consciousness may seem related, it is as absolutely distinct as it is from any of the ordinary phenomena of matter.

It has been argued that because physiological activity must be a property of every living cell, psychical activity must be equally so, and the language of the metaphysician has been carried into biology, and the "cell soul" spoken of as a conception inseparable from that of life.

That psychical phenomena, however, characterised as they essentially are by consciousness, are not necessarily coextensive with those of life, there cannot be a doubt. How far back in the scale of life consciousness may exist we have as yet no means of determining, nor is it necessary for our argument that we should. Certain it is that many things, to all appearance the result of volition, are capable of being explained as absolutely unconscious acts; and when the swimming swarm-spore of an alga avoids collision, and, by a reversal of the stroke of its cilia, backs from an obstacle lying in its course, there is almost certainly in all this nothing but a purely unconscious act. It is but a case in which we find expressed the great law of the adaptation of

living beings to the conditions which surround them. The irritability of the protoplasm of the ciliated spore responding to an external stimulus sets in motion a mechanism derived by inheritance from its ancestors, and whose parts are correlated to a common end—the preservation of the individual.

But even admitting that every living cell were a conscious and thinking being, are we therefore justified in asserting that its consciousness, like its irritability, is a property of the matter of which it is composed? The sole argument on which this view is made to rest is that from analogy. It is argued that because the life phenomena, which are invariably found in the cell, must be regarded as a property of the cell, the phenomena of consciousness by which they are accompanied must be also so regarded. The weak point in the argument is the absence of all analogy between the things compared, and as the conclusion rests solely on the argument from analogy, the two must fall to the ground together.

In a lecture[1] to which I once had the pleasure of listening—a lecture characterised no less by lucid exposition than by the fascinating form in which its facts were presented to the hearers, Prof. Huxley argues that no difference, however great, between the phenomena of living matter and those of the lifeless elements of which this matter is composed should militate against our attributing to protoplasm the phenomena of life as properties essentially inherent in it; since we know that the result of a chemical combination of physical elements may exhibit physical properties totally different from those of the elements combined; the physical phenomena presented by water, for example, having no resemblance to those of its combining elements, oxygen and hydrogen.

I believe that Prof. Huxley intended to apply this argument only to the phenomena of life in the stricter sense of the word. As such it is conclusive. But when it is pushed further, and extended to the phenomena of consciousness, it loses all its force. The analogy, perfectly valid in the former case, here fails. The properties of the chemical compound are like those of its components, still physical properties. They come within the wide category of the universally accepted properties of matter, while those of consciousness belong to a category absolutely distinct—one which presents not a trace of a connection with any of those which physicists have agreed in assigning to matter as its proper characteristics. The argument thus breaks down, for its force depends on analogy alone, and here all analogy vanishes.

That consciousness is never manifested except in the presence of cerebral matter or of something like it, there cannot be a question; but this is a very different thing from its being a property of such matter in the sense in which polarity is a property of the magnet, or irritability of protoplasm. The generation of the rays which lie invisible beyond the violet in the spectrum of the sun cannot be regarded as a property of the medium which by changing their refrangibility can alone render them apparent.

I know that there is a special charm in those broad generalisations which would refer many very different phenomena to a common source. But in this very charm there is undoubtedly a danger, and we must be all the more careful lest it should exert an influence in arresting the progress of truth, just as at an earlier period traditional beliefs exerted an authority from which the mind but slowly and with difficulty succeeded in emancipating itself.

But have we, it may be asked, made in all this one step forward towards an explanation of the phenomena of consciousness or the discovery of its source? Assuredly not. The power of conceiving of a substance different from that of matter is still beyond the limits of human intelligence, and the physical or objective conditions which are the concomitants of thought, are the only ones of which it is possible to know anything, and the only ones whose study is of value.

We are not, however, on that account forced to the conclusion that there is nothing in the universe but matter and force. The simplest physical law is absolutely inconceivable by the highest of the brutes, and no one would be justified in assuming that man had already attained the limit of his powers. Whatever may be that mysterious bond which connects organisation with psychical endowments, the one grand fact—a fact of inestimable importance—stands out clear and freed from all obscurity and doubt, that from the first dawn of intelligence there is with every advance in organisation a corresponding advance in mind. Mind as well as body is thus travelling onwards through higher and still higher phases; the great law of Evolution is shaping the destiny of our race; and though now we may at most but indicate some weak point in the generalisation which would refer consciousness as well as life to a common material source, who can say that in the far off future there may not yet be evolved other and higher faculties from which light may stream in upon the darkness, and reveal to man the great mystery of Thought?

[1] "The Physical Basis of Life" (see "Essays and Reviews," by T. H. Huxley).

SECTION D

BIOLOGY

Opening Address by Prof. St. George Mivart, F.R.S., Sec.L.S., V.P.Z.S., President of the Section

In responding to the honour which the authorities of the British Association have conferred in nominating me to fill this chair, I have deemed it best not to occupy your very valuable time with any matter of detail at which I may happen to have worked, but rather to offer to you a few remarks on questions which seem to me to have a general biological interest.

Last year my esteemed friend, Prof. Flower, called your attention to the great name of Linnæus. I propose this year to refer to Linnæus's illustrious contemporary, Buffon—not, however, in the character of a rival of Linnæus. Each was a man of genius, each did good work in his own way—work still bringing forth fruit. It must be admitted, however, that they were men of a very different stamp, and if it is necessary to express a relative judgment with respect to them, I should myself feel inclined to say that Buffon's mind had the greater aptitude for sagacious speculation, with an inferior power of acquiring and arranging a knowledge of facts of structure.

Various circumstances have concurred to favour our recollection of the merits of the great Swede, and to obscure those of the French naturalist. The well-earned fame of Linnæus is kept ever fresh in our memories by the necessarily frequent references to him in matters of nomenclature. On the other hand, not only are Buffon's claims on our esteem in no similar way brought before us, but those very speculative opinions of his, which are a merit in our eyes, have gained him disfavour with our immediate predecessors, whose opinions and sentiments we more or less inherit.

No one, however, can dispute Buffon's title to our grateful respect on account of the very powerful effect his writings had in stimulating men's love of nature, an effect which I think is not sufficiently appreciated.

It is fitting that I should call attention to his (once generally recognised) claims in this respect; since my own love of natural history is probably due to the circumstance that his great work was always accessible to me in my childhood, and was one of the earliest books with the pictures of which I was familiar.

Buffon was indeed Linnæus's contemporary, for the same year (1707) saw the births of both. In 1733 he was elected a member of the Academy of Sciences, and six years later was appointed superintendent of the Jardin du Roi,[1] which was the occasion of that work to which he is indebted for his fame, and to perfect which he displayed so much zeal in collecting specimens and in obtaining information respecting the various kinds of animals with which he became acquainted. His "Histoire Naturelle générale et particulière" began to appear in 1749, and in 1767 was published the fifteenth volume, which closed his history of mammals. Herein are contained those numerous anatomical illustrations (due, with their accompanying descriptions, to Daubenton) which have been again and again copied down to the present time. Next came nine volumes on birds, then his history of minerals, and, finally, seven supplementary volumes, the last of which appeared in 1789, the year after his death. His life was thus prolonged ten years beyond that of his illustrious contemporary, Linnæus.

Buffon can claim no merit as a classifier. With the exception of the Apes of the old and new worlds (which respectively fill the fourteenth and fifteenth volumes of his work), the beasts treated of are hardly arranged on any system, beyond that of beginning with the best known and most familiar—a system necessarily applicable to but a few forms.

[1] The Jardin du Roi was first instituted by Louis XIII. in 1628, and definitively established in 1635. It cannot be affirmed that Buffon enriched the incipient museum—the Cabinet du Roi—so much as might have been expected; although the skeletons which served for Daubenton's descriptions were, at least in many instances, preserved. It is to Geoffroy St. Hilaire that the magnificent museum of the Jardin des Plantes, which now exists, is most indebted.

But Buffon deliberately rejected the Linnæan classification—a grave error, certainly, yet one not altogether without excuse. Indeed, some of the objections he brought against that classification have considerable force. Such were his objections to the association of the hippopotamus, the shrew-mouse, and the horse in one order, and of the monkey and the manis in another.[1] What indeed could be more preposterous than the separation of the bat, *Noctilio leporinus*, from the other bats, and its association with the rodents, on the ground of its having (as supposed) only two incisor teeth above and two below?—an anomaly of arrangement of which you were reminded last year. It scarcely seems possible for the pedantry of classification to go farther than this. Yet, perhaps, the association in one group of the walrus, the elephant, the ant-eater, the sloth, and the manatee, was hardly less unphilosophical. Moreover, zoologists should not forget, in blaming Buffon for his want of appreciation of the classification of Linnæus, that one great portion of that classification—the classification of plants—has been superseded by us. Had he lived to witness the publication of Jussieu's "Genera Plantarum,"[2] it might have given him a truer insight into biological classification, and have led him to endeavour to improve on Linnæus' system instead of only criticising it.

But it is Buffon's speculative views which have most interest for us. Those views exercised a very wide-spread influence in their day, though the time was not ripe for them. Indeed, it is far from improbable that writers whose speculations have been made public at a more propitious season, owe much to their comparatively forgotten predecessor.

Amongst Buffon's various speculations we might glance at his "Théorie de la Terre" (put forth in the very first volume of his work), and at his "Epoques de la Nature," which fills the fifth volume of his supplement. We might consider his speculations concerning the formation of mountain and valley by water, and the evidence that there was present to the ear of his imagination:—

"The sound of streams, which, swift or slow,
Tear down Æolian hills and sow
The dust of continents to be."

That he saw, in thought, the projection of the planets from the sun's mass; the primitive fluidity of the earth, and the secular refrigeration of the sun. Such considerations, however, are foreign to this section. I will therefore select two which are of biological interest.

In the first place I may refer to Buffon's speculations concerning ANIMAL VARIATION. In this matter Isidore Geoffroy St. Hilaire has affirmed that Buffon stands to the doctrine of animal variability in a position analogous to that in which Linnæus stands to the doctrine of the fixity of species.

Buffon, in his chapter on the animals of the Old and New World, remarks,[3] "It is not impossible that the whole[4] of the new world's animals are derived from the same source as those of the old, whence they have descended." . . . . "Nature is in a state of perpetual flux." In this chapter on the degeneration of animals[5] he sums up saying, "After comparing all the animals, and arranging them each in their own group, we shall find that the two hundred kinds described here may be reduced to a small number of original forms, whence it may be all the rest have issued."

As to the modes and causes of the origin of new forms, he entertained four connected opinions:

(1) He attributed much modifying efficacy to migrations;

(2) Also to the direct action of external conditions;

(3) He believed largely in the origin of new forms by degradation; and

(4) He regarded each animal as the manifestation of an individuating force, living, as it were, at the root of the changes manifested by it.

The view that MIGRATION (with isolation) is a necessary antecedent to the origin of new species is one which has been advocated by a modern naturalist, Moritz Wagner;[6] who does not hesitate to affirm[7] that the formation of a nearly new species "will only succeed when a few individuals, having crossed the barriers of their station, are able to separate themselves for a long time from the old stock."

In support of his view the author brings forward a multitude of interesting facts, one of the most significant of which appears to me to be the following. It concerns Beetles of Tropical America of the genus *Tetracha*. In Venezuela, and in the western part of Central America, he tells us rivers flow partly through savannahs, where they have undermined the light tufaceous soil, forming deep beds with high precipitous banks. According to Prof. Wagner, individual beetles from the highlands have thus been isolated, and in no longer time than has been required by the rivers to undermine the loose soil of the savannah, have given rise to a distinct species markedly different in form and colour. It is to similar causes—migration and complete isolation—that he traces the formation of distinct races of men: a formation he deems no longer possible, while the wide diffusion of mankind renders more and more difficult the evolution of new species of animals of any kind.

Instances which appear to support this view will readily suggest themselves to the naturalist—instances, that is, of forms which are both peculiar in structure and remote and isolated as to their habitat.[1] Thus for example, even in the group which structurally most resembles us, we have the Orang confined to very limited tracts in Borneo and Sumatra, and the Gorilla to a small portion of Western Africa. The Proboscis Monkey is found nowhere but in Borneo, while the singular ape named "Roxellana," (from its wonderfully "tip-tilted" nose) is confined to the lofty and isolated mountains of Monpin in Thibet. The very peculiar black ape (*Cynopithecus*) is limited to Celebes and Batchian, while the Baboon, which has the baboon character of muzzle most developed, was found at the extreme south of the African continent.

Again, if we take the group of Lemur-like animals (*Lemuroidea*) as having had their home and starting-point in or near their present head-quarters—Madagascar—then some of the most aberrant forms are those which must have migrated farthest. The character which is perhaps the most peculiar of any which the group presents, is the elongation of two of the ankle-bones, as we find it in the Madagascar genus *Cheirogaleus*. But this character is more exaggerated in migrants to Africa—the Galagos—and most so of all in the more isolated emigrant, the Tarsier, now found in Celebes and Borneo.

The sub-family of slow-lemurs (*Nycticebinæ*) would, on this view, seemed to have migrated in opposite directions, as we find the slender slow-lemur (*Loris*) in Madras, Malabar, and Ceylon; the typical slow-lemur (*Nycticebus*) in South China, Borneo, and Java; the Potto (*Perodicticus*) in Sierra Leone, and the Angwantibo (*Arctocebus*) in Old Calabar. Of these, it is the African forms which have the index-finger most atrophied—a tendency to its atrophy existing in the whole sub-family.

It would, of course, be very easy to multiply instances of the kind; but it would be also easy to cite a number of cases which appear to conflict with the view in question. Thus familiar to us as it is, few animals are more peculiar in structure than the common mole, which gives no present evidence of isolated origin; and the most aberrant of all bats, the Vampire (*Desmodus*), is rather widely distributed in South America. Again, with regard to the Lemur group, the most absolutely exceptional is the Aye-Aye (*Cheiromys*), which, on the hypothesis supposed, has remained persistently at the head-quarters of the group, *i.e.* in Madagascar.

Even, however, if no exception existed to the co-existence now of singularity of form and isolation and remoteness of situation, we could not safely draw any decided conclusion from such facts, because fossil remains show us that forms which have now a very limited distribution, were either widely spread in earlier times, or existed in regions very remote from those they now inhabit. Thus, in Eocene times there existed in Europe true opossums (now confined to America), Tapirs, and a form like the African Potto before mentioned. In Miocene times we had in Europe long-armed apes (creatures now found only in Eastern Asia), with the now exclusively African Secretary Bird and Cape Ant Eater (*Orycteropus*). In the same period the Orang—or a nearly allied form—seems to have ranged over

[1] "Hist. Nat." tome i. p. 39.

[2] This appeared in 1789.

[3] *Op. cit.* vol. ix. p. 127.

[4] He thought that the American Jaguars, Ocelots, &c., and even the Peccary, were positive degradations of old world forms. He thought that the Llama, the American Apes, Agoutis, and Ant-eaters might be examples of such forms; but the Opossum, Sloths, and Tapirs he took to be original species. (See vol. xiv. pp. 272, 273.)

[5] Vol. xiv. p. 358.

[6] In a paper read before the Royal Academy of Sciences at Munich on March 2, 1868. This has been translated by Mr. James L. Laird, and published by Edward Stanford in 1873.

[7] *Op. cit.* p. 29.

[1] Isolation, it ought to be remembered, may take place as the result not only of changes in inorganic nature (such as the formation of islands, and the excavation of river beds), but also by the presence of enemies in intermediate tracts, by the circumstance that the food of the species is found only in certain restricted localities, and by whatever other causes determine the extinction of a species in a given place.

India. What are more emphatically old world forms than the camel, horse, and elephant, with the typical porcupine? Yet all these existed in America in Pliocene times. Did we know the Tapir in only one of the two widely-separated stations in which it dwells to-day, we might well deem its evolntion to be due to migration and isolation. But we know from palæontology that it existed in Europe from the Eocene to the Pliocene period.

Such facts as these do not, of course, disprove the doctrine that migration and isolation are necessary antecedent conditions to specific genesis, but they show how much caution must be used in drawing the conclusion that they are necessary, from the distribution of animals much less likely to be found fossil than mammals are.

But an argument in favour of the views of Buffon and of Wagner may be obtained from our own species, which exhibits some singular coincidences between peculiarity of form and isolation. Among such instances may be mentioned the Tasmanians, the Andaman Islanders, and the Aïnos or Aborigines of Japan. One of the most striking examples is that of the Eskimo—a people representing many peculiarities, some of which exaggerate the characters of the highest races of mankind. Thus, the pelvis differs from the European pelvis in an opposite direction to that by which the negro pelvis differs from the European, and the same is the case with the proportions of the limbs, while the skulls of the Eskimo have the largest and narrowest nasal aperture of all races, being in this respect the very opposite to the Australians. The Eskimo have migrated eastwards, not reaching the south of Greenland till the fourteenth century, and the race characters are most marked in the most easterly tribes. These facts were brought forward by Prof. Flower in his Hunterian lectures for the present year,[1] when he said that the characters of this peculiar race "must be attributed to those gradual modifications produced by causes at present little understood, by which most of the striking variations met with in the human species have been brought about—modifications more strongly expressed the more completely isolated the race has become, and the farther removed from its original centre of distribution." I think, then, that though we have not data for conclusively answering the question as to how far migration (together with isolation) may be necessary for specific genesis, it is certain that it is of very great efficacy and importance, and that credit is justly due to Buffon for his early appreciation of its importance.

The next question to which I would advert is that concerning THE DIRECT ACTION UPON ORGANISMS, OF THE EXTERNAL CONDITIONS WHICH SURROUND THEM.

Buffon's belief was[2] that changes of specific form were brought about by change of temperature and climatic change generally, as well as by change of food.

The curious effects of stimulating food on colour—as of cayenne pepper with canaries, and hemp-seed with parrots—is notorious.

The direct action of the environment on organisms has, I think, been of late somewhat undervalued. Amongst evidences in favour of its importance, I would refer to some of Mr. Alfred Wallace's observations.[3] He tells us that in the small island of Amboina, the butterflies (twelve species of nine different genera) are larger than those of any of the more considerable islands about it, and that this is an effect plainly due to some local influence. In Celebes, a whole series of butterflies are not only of a larger size, but have the same peculiar form of wing. The Duke of York's Island seems, he tell us, to have a tendency to make birds and insects white or at least pale, and the Philippines, to develop metallic colours, while the Moluccas and New Guinea seem to favour blackness and redness in parrots and pigeons. Species of butterflies which in India are provided with a tail to the wing, begin to lose that appendage in the islands, and retain no trace of it on the borders of the Pacific. The Æneas group of Papilios never have tails in the equatorial region of the Amazon Valley, but gradually acquire tails, in many cases, as they range towards the northern and southern tropics. Mr. Gould says that birds are more highly coloured under a clear atmosphere than in islands or on coasts—a condition which also seems to affect insects, while it is notorious that many shore plants have fleshy leaves. I need but refer to the English oysters mentioned by Costa, which, when transported to the Mediterranean, grew rapidly like the true Mediterranean oyster, and to the twenty different kinds of American trees, said by Meehan to differ in the *same manner* from their nearest European allies, as well as to the dogs, cats, and rabbits which have been proved to undergo modifications directly induced by climatic change.

It appears, then, that much may be said in favour of that direct effect of surrounding circumstances on organisms in which Buffon believed.

Lastly, I would refer to Buffon's belief that new species have arisen by DEGRADATION. This again is an opinion which, after a period of disfavour, or at least of neglect, has been of late revived, and has acquired considerable influence. I may here refer to Anton Dohrn, who has recently advocated the very widely-spread and effective action of degradation as a cause of specific change. It will, I think, be generally admitted that such exceptional Copepod crustaceans as *Tracheliastes* and *Lernæocera* are due to degradation, and the probability seems to me very strong that the Rhizocephala, at least many cirripeds, and the certoid worms, are also degraded organisms. Very interesting would it be to know whether existing Ascidians are also examples of degradation, as not a few zoologists now suppose; but most interesting of all is that parasite of cuttle fishes, *Dicyema*, the structure of which has been recently investigated by Prof. Eduard van Beneden, and made the type of a new primary division of animals. Should this small worm-like organism hereafter turn out to be a degraded form, it will show what an extreme degree of retrograde metamorphosis may occasionally be brought about. I think, then, that we have considerable ground for suspecting that degradation has acted much and widely in the field of Biology, and if so, Buffon is fairly entitled to a certain amount of esteem on account of the views he entertained with regard to it in so early a day and in so undeveloped a condition of zoological science. For it must not be forgotten that migration, the influence of external conditions, and degradation, are connected points: parts of one view. Degradation is most conspicuous under violent changes of condition (such as parasitism), while migration only acts by bringing organisms under new conditions.

These reflections lead me to urge upon such of my hearers as may have any unusual facilities for experimental investigation, a course of inquiry which seems to be very desirable.

What is needed in order to solve as far as possible the question of specific genesis, is a knowledge of the laws of variation, which must, I think, be deemed the true cause and origin of species.

We may, I think, accept as true two propositions:—

1. Animals may change in various ways, and amongst them, by degradation.

2. Changes in the environment with isolation, induce and favour changes in form.

I would urge, then, that inquiries should be pursued in two directions simultaneously.

A. There might be undertaken one set of inquiries to investigate the effects on different species of the same variations of environment.

B. Other inquiries might be undertaken with a view to ascertaining the effects of different changes of environment on one and the same species. By series of experiments contrived with these ends in view, and carried on with various selected animals and plants which reproduce with rapidity, we may possibly be able to determine what to attribute to external influences (shown by such influence having the same effects on all), and what to the peculiar nature and innate powers and tendencies of different organisms—shown by the diverging reactions of the latter under the same changes in their environment.

I next desire to direct your attention to another matter treated of by Buffon—I mean THE RESEMBLANCES AND DIFFERENCES WHICH EXIST BETWEEN THE MIND OF MAN AND THE HIGHER PSYCHICAL FACULTIES OF ANIMALS.

This question is eminently a question of our own day, and one which I feel cannot but excite interest in this section.

But its accurate investigation is attended with special difficulties, and amongst them are two temptations, which are apt to beset the inquirer;

1. The first of these arises from the wide-spread love for the marvellous of whatsoever kind, and the tendency to inverted anthropomorphism.

[1] The lecturer also said: "The large size of the brain of all the hyperborean races, Lapps as well as Eskimo, seems not necessarily to be connected with intellectual development, but may have some other explanation not at present apparent." I would suggest that in this case—as in the large brains of Cetaceans—it may be due to the need in their climate of generating much heat to sustain the necessary temperature of the body.

[2] *Op. cit.*, vol. xiv. p. 317.

[3] See "Tropical Nature," pp. 254–259.

2. The other is the temptation to strain or ignore facts to serve a favourite theory.

As to the former of these dangers, I may perhaps be permitted to quote some remarks made by Mr. Chambers, approvingly cited by Prof. Bain: "There are two subjects where the love of the marvellous has especially retarded the progress of correct knowledge—the manners of foreign countries, and the instincts of the brute creation. . . . . It is extremely difficult to obtain true observations" as to the latter "from the disposition to make them subjects of marvel and astonishment." . . . . "It is nearly as impossible to acquire a knowledge of animals from anecdotes as it would be to obtain a knowledge of human nature from the narratives of parental fondness and friendly partiality." This I believe to be most true, and that here the danger of mistaking inference for observation is exceptionally great. The inquirer ought not to accept as facts marvellous tales without criticism and a careful endeavour to ascertain whether the alleged facts are facts and not unconscious fictions.

As to the second danger, the lamented George Henry Lewes, whom no one can suspect of any hostility to evolution in its most extreme form, remarks (in his posthumous work[1] just published) that the researches of various eminent writers on animal psychology have been "biassed by a secret desire to establish the *identity* of animal and human nature," and certainly no one can deny that those who do assert that identity, are necessarily exposed to the temptation referred to. Of course persons who desire to disprove this identity are exposed to the opposite temptation; but it cannot be maintained that there is evidence of Buffon having been influenced by any such desire.

The obvious difference between the highest powers of man and animals has led the common sense of mankind to consider them to be of radically distinct kinds, and the question which naturalists now profess to investigate is whether this is so or no.

But we may doubt, whether many who enter upon this inquiry do not enter upon it with their minds already made up that no such radical difference can by any possibility exist. To admit it, they think, would be tantamount to admitting some non-natural origin of man, to accepting, as a fact, something not harmonising with our views as to nature generally, leading to we know not what results—possibly even to lending some support to Christianity. To admit it, would be to deny the principle of continuity. There cannot, therefore, be any essential difference between man and brute, and their mental powers must be the same in kind. This, I think, is no unfair representation of the state of mind in which this question is very likely to be entered upon at the present time. Surely, however, if we profess to investigate a question, we ought in honesty to believe that there *is* a question to investigate, or else leave the matter to others; and if evidence should seem to show that "intellect" *cannot* be analysed into sense, but is an ultimate, it ought to be accepted, at the least provisionally, as such, even at the cost of having to regard its origin as at present inexplicable. Can we explain the origin of "motion?" But what rational man thinks of denying it on that account? Let us not reject anything, then, which may be evident, on account of certain supposed speculative consequences.

But that no such consequences as those referred to need follow from the admission of the radical distinctness of human reason, seems evident from the views of Aristotle. He certainly was free from theological prejudices or predispositions, and yet to his clear intellect the difference between the merely sentient and the rational natures was an evident difference, and the facts which are open to our observation are the same as those which presented themselves to his.

To enter on this inquiry with any fair prospect of success, it is not only necessary to guard against such temptations as these, but it is also necessary to be provided with a certain amount of knowledge of a special kind; namely, with a clear knowledge of what our own intellectual powers are. I conceive that, great as is the danger of exaggeration and false inference as to the faculties of animals, the danger of misapprehending and underrating our own powers is far greater.

Buffon held very decided views as to the distinctness of the mind of man from the so-called minds of animals. But an ingenious and gifted writer,[2] who has recently done good service in supporting Buffon's claims to greater consideration than he commonly receives, has, nevertheless, done him what I believe to be strange injustice in attributing to his great work an ironical character, and this in spite of Buffon's protest[1] against irony in such a work as his. I cannot venture to take up your time with controversy on this subject; but apart from Buffon's protest against "équivoque," it is incredible to me that he should have carried on a sustained irony through so voluminous a work—thus making its whole teaching absolutely mendacious. One remark of Buffon's, which has been strangely misinterpreted by this writer, I shall have occasion to notice directly; but I think it may suffice to clear Buffon's character from the aspersion of his admiring assailant, to point out that in the table of contents in the final volume of his "History of Mammals"[2] (which table gives the pith and gist of his several treatises), he distinctly affirms the distinctions maintained in the body of his work.

[1] "Problems of Life and Mind." Third Series, 1879, p. 122.

[2] Mr. Samuel Butler. See his "Evolution, Old and New." (Hardwicke and Bogue, 1879.)

The following were Buffon's views. In his "Discourse on the Nature of Animals,"[3] he says, "Far from denying feelings to animals, I concede to them everything except thought and reflection" . . . . "they have sensations, but no faculty of comparing them one with another, that is to say, they have not the power which produces ideas." He is full of scorn[4] for that gratuitous admiration for the moral and intellectual faculties of bees, which Sir John Lubbock's excellent observations and experiments have shown to be indeed gratuitous. Speaking of the ape, most man-like (and *so* man-like) as to brain, he says:[5] "Il ne pense pas: y a-t-il une preuve plus évidente que la matière seule, quoique parfaitement organisée, ne peut produire ni la pensée, ni la parole qui en est le signe, à moins qu'elle ne soit animée par un principe supérieur?"[6] Buffon has been accused of vacillation with respect to his doctrine concerning animal variation, but no one has accused him of vacillation with respect to his views concerning reason and instinct.

I come now to the passage which I said has been so strangely misunderstood. It is that in which he expresses his conviction that "animals have no knowledge of the past, no idea of time, and consequently no memory." But to quote this passage without explanation is gravely to misrepresent the illustrious French naturalist. Buffon was far from ignoring, indeed he distinctly enumerates the various obtrusive phenomena which often lead the vulgar to attribute, without qualification, both knowledge and memory to brutes. But, in fact, he distinguishes between[7] memory and memory. His words are: "Si l'on a donné quelque attention à ce que je viens de dire, on aura déjà senti que je distingue deux espèces de mémoire infiniment différentes l'une de l'autre par leur cause, et qui peuvent cependant se ressembler en quelque sorte par leurs effets; la première est la trace de nos idées, et la seconde, que j'appellerais volontiers réminiscence[8] plutôt que mémoire, n'est que le renouvellement de nos sensations," and he declares[9] true memory to consist in the recurrence of ideas as distinguished from revived sensuous imaginations.

This distinction is one which it is easy to perceive. That we have automatic memory, such as animals have, is obvious; but the presence of intellectual memory (or memory proper) may be made evident by the act of searching our minds (so to speak) for something which we know we have fully remembered before, and thus intellectually remember to have known, though we cannot now bring it before our imagination.

As with memory, so with other of our mental powers, we may, I think, distinguish between a higher and a lower faculty of each; between our higher, self-conscious, reflective mental acts—the acts of our intellectual faculty—and those of our merely sensitive power. This distinction (to which I have elsewhere[10] called attention) I believe to be one of the most fundamental of all the distinctions of biology, and to be one the apprehension of which is a necessary preliminary to a successful investigation of animal psychology. It is, of course, impossible for us thoroughly to comprehend the minds of dogs or birds, because we cannot enter into the actual experience of such animals, but by understanding the distinction between our own higher and

[1] *Op. cit.* tome i. p. 25. [2] *Op. cit.* tome xv. [3] *Op. cit.* tome iv. p. 41.

[4] *Op. cit.* tome iv. p. 91. [5] *Op. cit.* tome xiv. p. 61.

[6] Mr. Butler cites objections brought forward in a certain passage (from pp. 30 and 31, vol. xiv.), as if they were Buffon's own. But they are the objections of an imagined opponent whose views Buffon himself combats. It is worthy of note that Buffon long anticipated our contemporaries with respect to man's place in nature in so far as concerns his mere anatomy. For he did not hesitate to affirm that the Orang differs less from us structurally than it differs from some other apes.

[7] *Op. cit.* tome iv. p. 60.

[8] Here he follows, without citing, the old distinction of Aristotle between memory and reminiscence.

[9] *Op. cit.* tome iv. p. 56.

[10] "Lessons from Nature" (Murray, 1876), p. 196.

lower faculties,[1] we may, I think, more or less approximate to such a comprehension.

It may, I believe, be affirmed that no animal but man has yet been shown to exhibit true concerted action, or to express by external signs distinct intellectual conceptions—processes of which all men are normally capable. But just as some plants simulate the sense perception, voluntary motions and instincts of animals, without there being a real identity between the activities thus superficially similar, so there may well be in animals actions simulating the intellectual apprehensions, ratiocinations, and volitions of man without there being any necessary identity between the activities so superficially alike. More than this, it is certain, *à priori*, that there must be such resemblance, since our organisation is similar to that of animals, and since sensations are at least indispensable antecedents to the exercise of our intellectual activity.

I have no wish to ignore the marvellous powers of animals or the resemblance of their actions to those of man. No one can reasonably deny that many of them have feelings, emotions, and sense-perceptions similar to our own; that they exercise voluntary motion and perform actions grouped in complex ways for definite ends; that they to a certain extent learn by experience, and can combine perceptions and reminiscences so as to draw practical inferences, directly apprehending objects standing in different relations one to another, so that, in a sense, they may be said to apprehend relations. They will show hesitation, ending apparently, after a conflict of desires, with what looks like choice or volition, and such animals as the dog will not only exhibit the most marvellous fidelity and affection, but will also manifest evident signs of shame, which may seem the outcome and indication of incipient moral perceptions. It is no great wonder, then, that so many persons, little given to patient and careful introspection, should fail to perceive any radical distinctions between a nature thus gifted and the intellectual nature of man.

But, unless I am greatly mistaken, the question can never be answered by our observations of animals, unless we bear in mind the distinctions between our own higher and lower faculties.

Now I cannot here even attempt to put before you what I believe to be the true view of our own intellectual processes. Still I may, perhaps, be permitted to make one or two passing observations.

Everybody knows his own vivid feelings (or sensations), and those faint revivals of feelings, simple or complex, distinct or confused, which are imaginations and emotions; but the same cannot be said as to thought. Careful introspection will, however, I think, convince any one that a "thought" is a thing widely different from an "imagination"—or revival of a cluster of faint feelings. The simplest element of thought seems to me to be a "judgment," with an intuition of reality concerning some "fact," regarded as a fact real or ideal. Moreover, this judgment is not itself a modified imagination, because the imaginations which may give occasion to it persist unmodified in the mind side by side with the judgment they have called up. Let us take, as examples, the judgments "that thing is good to eat," and "nothing can be and not be at the same time and in the same sense." As to the former, we vaguely imagine "things good to eat," but they exist *beside* the judgment, not *in* it. They can be recalled, compared, and seen to co-exist. So with the other judgment, the mind is occupied with certain abstract ideas, though the imagination has certain vague "images" answering respectively to "a thing being" and "a thing not being," and to "at the same time" and "in the same sense;" but the images do not *constitute* the judgment itself any more than human "swimming" is made up of "limbs and fluid," though without such necessary elements no such swimming could take place.

This distinction is also shown by the fact that one and the same idea may be suggested to, and maintained in, the mind by the help of the most incongruous images, and very different ideas by the very same image. This we may see to be the case with such ideas as "number," "purpose," "motion," "identity," &c.

But the distinctness of "thought" from "imagination" may perhaps be made clearer by the drawing out fully what we really do when we make some simple judgment, as, *e.g.*, that "a negro is black." Here, in the first place, we directly and explicitly affirm that there is a conformity between the external thing, "a negro," and the external quality, "blackness"—the negro possessing that quality. We affirm secondarily and implicitly a conformity between the two external entities and the two corresponding internal concepts. And thirdly, and lastly, we also implicitly affirm the existence of a conformity between the subjective judgment and the objective existence.

All that it seems to me evident that sentience can do is to associate feelings and images of sensible phenomena, variously related, in complex aggregations, but not to apprehend sensations as "facts" at all, still less as internal facts, which are the signs of external facts. It may be conceived as marking successions, likenesses and unlikenesses of phenomena, but not as recognising such phenomena as *true*. Animals, as I have fully admitted, apprehend things in different relations, but no one that I know of has brought any evidence that they apprehend them *as* related, or their relations *as* relations. A dog may feel shame, or possibly (though I do not think probably) a migrating bird may feel agony at the imagination of an abandoned brood; but these feelings have nothing in common with an ethical judgment, such as that of an Australian, who, having held out his leg for the punishment of spearing, judges that he is wounded more than his common law warrants.

Animals, it is notorious, act in ways in which they would not act had they reason; while, as far as I have observed or read, all they do is explicable by the association of sensations, imaginations, and emotions, such as take place in our own lower faculties. We cannot, of course, prove a negative, but we have no right to assume the existence of that for which there is no evidence, without which all the facts can be explained, and which, if it did exist, would make a multitude of observed facts impossible. Apes (like dogs and cats) warm themselves with pleasure at deserted fires, yet, though they see wood burning and other wood lying by, though they have arms and hands as we have, and the same sentient faculties, they have never, so far as I know, been recorded to have added fuel to maintain their comfort. Swallows will continue to build on a house which they see has begun to be pulled down, and no animal can be shown to have made use of antecedent experience to *intentionally* improve upon the past.

If, on the other hand, animals were capable of deliberately acting in concert, the effects would soon make themselves known to us so forcibly as to prevent the possibility of mistake.

Mr. Lewes has not hesitated to affirm[1] that "between animal and human intelligence there is a gap which can only be bridged over by an addition from without," and he also says:[2] "The animal world is a continuum of smells, sights, touches, tastes, pains, and pleasures: it has no objects, no laws, no distinguishable abstractions, such as self and not self. . . . If we see a bud, after we have learned that it is a bud, there is always a glance forward at the flower and backward at the seed . . . . but what animal sees a bud at all except as a visible sign of some other sensation?" As a friend of mine, Prof. Clarke,[3] has put it: "In ourselves sensations presently set the intellect to work; but to suppose that they do so in the dog is to beg the question that the dog has an intellect. A cat to bestir itself to obtain its scraps after dinner, need not entertain any *belief* that the clattering of the plates when they are washed is usually accompanied by the presence of food for it, and that to secure its share it must make certain movements; for quite independently of such belief, and by virtue of mere association, the simple objective conjunction of the previous sounds, movements, and consequent sensations of taste, would suffice to set up the same movements on the present occasion." Let certain sensations and movements become associated, and then the former need not be noted: they only need to exist for the association to produce its effects, and simulate apprehension, deliberation, inference, and volition. "When the circumstances of any present case differ from those of any past experience, but imperfectly resemble those of many past experiences, parts of these, and consequent actions, are irregularly suggested by the laws of resemblance, until some action is hit on which relieves pain or gives pleasure. For instance . . . . let a dog be lost by his mistress in a field in which he has never been before. The presence of the group of

[1] Certain writers (as, for example, Prof. Ewald Hering, of Prague) have used the word "memory" to denote what should properly be called "organic habit," *i.e.*, the power and tendency which living beings have to perpetuate in the future, effects wrought on them in the past. But to call such action, as that by which a tree as it grows, preserves the traces of scars inflicted on it years before, "memory," is a gross abuse of language—a use of the word as unreasonable as would be the employment of the word "sculptor" to denote a quarryman, or "sculpture" to indicate the fractures made in rocks by the action of water and frost.

[1] "Problems of Life and Mind," vol. i. p. 156.

[2] *L.c.*, p. 140.

[3] "Questions on Psychology," p. 9.

sensations which we know to indicate his mistress is associated with pleasure, and its absence with pain. By past experience an association has been formed between this feeling of pain and such movements of the head as tend to recover some part of that group, its recovery being again associated with movements which, *de facto*, diminish the distance between the dog and his mistress. The dog, therefore, pricks up his ears, raises his head and looks round. His mistress is nowhere to be seen; but at the corner of the field there is visible a gate at the end of a lane which resembles a lane in which she has been used to walk. A phantasm (or image) of that other lane, and of his mistress walking there, presents itself to the imagination of the dog; he runs to the present lane, but on getting into it she is not there. From the lane, however, he can see a tree at the other side of which she was wont to sit; the same process is repeated, but she is not to be found. Having arrived at the tree he thence finds his way home." By the action of such feelings, imaginations, and associations—which we know to be *veræ causæ*—I believe all the apparently intelligent actions of animals may be explained without the need of calling in the help of a power, the existence of which is inconsistent with the mass, as a whole, of the phenomena they exhibit.

But if there *is* a radically distinct intellectual power or force in man, is such a distinction of kind so isolated a fact as many suppose? May there not exist between the forces which living beings exhibit other differences of kind?

Each living being consists of an aggregation of parts and functional activities which are evidently knit together into a unity. Each is somehow the seat or theatre of some unifying power or condition which synthesises their varied activities, and is a PRINCIPLE OF INDIVIDUATION. This seems certainly to have been the opinion of Buffon, and it is to this opinion that I referred in speaking of the fourth cause to which he attributed the changes in organic forms. And to me it seems that we must admit the existence of such a living principle. We may analyse the activities of any animal or plant, and by consideration of them separately find resemblances between them and mere physical forces. But the *synthesis* of such forces as we find in a living creature is certainly nowhere to be met with in the inorganic world.

To deny this would be to deny the plainest evidence of our senses. To assert that each living body is made up of minute independent organisms, each with its own "principle of individuation," and without subordination or co-ordination, is but to multiply difficulties, while such a doctrine conflicts with the evidence of our own perceptions, which lead each of us to regard himself as one whole—a true unity in multiplicity.

The existence in each creature of a peculiar, co-ordinating, polar force, seems to be specially pointed to by the phenomena of serial and bilateral symmetry, by the symmetrical character of certain diseases, by the phenomena of monstrous growths and by the symmetrical beauty of such organisms as the Radiolarian Rhizopods.

It also seems to me to be made evident, by the various activities of each animal, which are, as a fact, grouped in one in mutual interaction—an organism having been described by Kant as a creature, the various parts of which are reciprocally ends and means.

I think now I hear the exclamation—This is "Vitalism!" while some of my hearers may deem these matters too speculative for our Section.

But consciously or unconsciously, general conceptions of the kind exist in the minds of all biologists, and influence them in various ways, and their consideration therefore can hardly be out of place here; while as to "Vitalism," I am convinced I shall not be wasting your time in endeavouring to remove a widespread misconception.

The "Vitalism" which is so reasonably objected to, is that which supposes the existence in each living creature of some separate entity inhabiting the body—an extra-organic force within the living creature, and acting by and through it, but numerically distinct from it. But the view which I venture to put before you as that which is to my judgment a reasonable one, is that of a peculiar form of force which is *intra-organic*, so that it and the visible living body are one thing, as the impress on stamped wax and the wax itself are one, though we can ideally distinguish between the two. It is, in fact, a mode of regarding living creatures with prime reference to their activities rather than to their material composition, and every creature can of course be regarded either statically or dynamically. It is to regard any given animal or plant, not as a piece of complex matter played upon by physical forces, which are transformed by what they traverse, but rather as a peculiar immanent principle[1] or form of force (whensoever and howsoever arising), which for a time manifests itself by the activities of a certain mass of complex material, with which it is so entirely one that it may be said to constitute and *be* such animal or plant much rather than the lump of matter which we can see and handle can be said to constitute such animal or plant. On this view a so-called "dead bird" is no bird at all, save by abuse of language, nor is a "corpse" really a "dead man"—such terms being as self-contradictory as would be the expression "a dead living creature."

Thus the real essence, the substantial constituent of every living thing is something which escapes our senses, though its existence and nature reveal themselves to the intellect.

For of course our senses can detect nothing in an animal or plant beyond the qualities of its material component parts. But neither is the function of an organ to be detected save in and by the actions of such organ, and yet we do not deny it its function or consider that function to be a mere blending and mixture of the properties of the tissues which compose it. Similarly it would seem to be unreasonable to deny the existence of a living principle of individuation because we can neither see nor feel it, but only infer it. This power or polar force, which is imminent in each living body, or rather which is that body living, is of course unimaginable by us, since we cannot by imagination transcend experience, and since we have no experience of this force, save as a body living and acting in definite ways.

It may be objected that its existence cannot be verified. But what *is* verification? We often hear of "verification by sensation," and yet even in such verification the ultimate appeal is not really to the senses, but to the intellect, which may doubt and which criticises and judges the actions and suggestions of the senses and imagination. Though no knowledge is possible for us which is not genetically traceable to sensation, yet the ground of all our developed knowledge is not sensational, but intellectual, and its final justification depends, and *must* depend, not on "feelings," but on "thoughts." I must apologise to such an audience as that I have the honour of addressing for expressing truths, which, to some of my hearers, may appear obvious. I would gladly suppress them as superfluous did not my own experience convince me that they are not superfluous. To proceed: "Certainty" does not exist at all in *feelings* any more than doubt. Both belong to thought only. "Feelings" are but the materials of certainty, and though we can be perfectly certain about our feelings, that certainty belongs to thought and to thought only. "Thought," therefore, is our absolute criterion. It is by self-conscious thought only that we know we have any feelings at all. Without thought, indeed, we might feel, but we could not know that we felt or know ourselves as feeling. If, then, we have *rational* grounds for the acceptance of such a purely intellectual conception as that of an immanent principle as the essence of each living creature, the poverty of our powers of imagination should be no bar to its acceptance. We are continually employing terms and conceptions—such, *e.g.*, as "being," "substance," "cause," &c.—which are intelligible to the intellect (since they can be discussed), though they transcend the powers of the imagination to picture.

It seems to me that the spirit which would deny such realities is the same spirit which would deny our real knowledge of an external world at all, and represent any material object as "state of consciousness," and at the very same time represent "a state of consciousness" as the accompaniment of a peculiar state of a material object—the body.[2] This mode of representation may

[1] The word "principle" has been used to denote that activity which, together with material substance, constitutes a living creature, because that word calls up a less sensuous, and therefore less misleading, phantasm than any other. The old term ψυχή, or soul, has in modern times come to be associated with the idea of a substance numerically distinct from the living body, and capable of surviving the destruction of the latter. But as structure and function ever vary together (as do the convexities and concavities of a curved line), so "the principle of individuation" or soul of an animal or plant and its material organisation must necessarily arise, vary, and be destroyed simultaneously, unless some special character, as in the case of man, may lead us to consider it exceptional in nature. Even in man, however, there seems no adequate reason for believing in the existence of any principle of individuation, save that which exerts its energy in all his functions, the humblest as well as the most exalted.

[2] Those who deny that we have a real power of perceiving objects, refute themselves when they speak of "purely physical changes," or of anything "physical" of which feelings are but the "accompaniment" or "subjects." For according to them "matter" is but a term for certain "states of consciousness," while they represent each state of consciousness as a function of matter. According to this, let *a* represent a "state of consciousness, and

be shortly, but not unjustly, described as a process of intellectual "thimble-rigging," by which the unwary spectator is apt to be cheated out of his most valuable mental possession—his rational certainty.

The same spirit asserts that our psychical powers never themselves enter into the circuit of physical causation, and yet few things would seem more certain to a plain man than that (supposing him to have received a message saying his house is on fire) it is his *knowledge* of what has been communicated which sets him in motion. To deny this is to deny the evident teaching of our consciousness. It is to deny what is necessarily the more certain in favour of what is less so. If I do not know this I know *nothing*, and discussion is useless. As a distinguished writer has said: "That we are conscious, and that our actions are determined by sensations, emotions, and ideas, are facts which may or may not be explained by reference to material conditions, but which no material explanation can render more certain." The advocate of "natural selection" may also be asked, How did knowledge ever come to be, if it is in no way useful, if it is utterly without action, and is but a superfluous accompaniment of physical changes which would go on as well without it?

As we may be confident that thought not only is but also acts, as well as that there are things which are not psychical, but which are physical; so I would urge that the conception of living things, which I venture to put before you, is one which may be rationally entertained.

Assuming for the moment and for argument's sake that it may be accepted, what light does our knowledge of ourselves throw upon the intimate life-processes of lower organisms? We know that with us a multitude of actions, which are at first performed with consciousness, come to be performed unconsciously; we know that we experience sensations[1] without perceiving them; we know also that countless organic activities take place in us under the influence and control of the nervous system, which either never rise into consciousness at all, or only do so under abnormal conditions. Yet we cannot but think that those activities are of the same generic nature, whether we feel, perceive, or attend to them or not. The principle of individuation in ourselves, then, evidently acts with intelligence in some actions, with sentience in many actions, but constantly in an unperceived and unfelt manner. Yet we have seen it undeniably intervene in the chain of physical causation.

An animal is an organism all the actions of which are necessarily determined by the adjustments of its various organs, and by its environment. But even its sensations cannot be regarded as mere accompaniments of its activities, but as guides and directing agencies intervening in the circle of its actions, and as facts, in the chain of physical causation. The sight of a stick may change the course of actions which a dog would otherwise have pursued—that is, the feeling of the moment, together with the faint recurrence of various past feelings and emotions therewith associated which the sight of the stick calls up, may cause such change. Besides its feelings, the general and the organic movements of the dog are, like our own, governed by a multitude of organic influences which are not felt, but which operate through the nervous system, and so must be taken as parallel with those which are felt, *i.e.* as unfelt, nervous psychoses. The animal, then, like each of us, is a creature of activities partly physical, partly psychical, the latter—both the felt and the unfelt—being directive and controlling.

As we descend to the lowest animals, the evidence as to sentience fades. Yet from the resemblances of the lowest animals and plants, and from the similarity of the vegetative functions in all living creatures, we may, I think, analogically conclude that activities also take place in plants which are parallel with, and analogous to, the unfelt psychoses of animals. As Asa Gray has said with respect to their movements: "Although these are incited by physical agents (just as analogous kinds of movements are in animals), and cannot be the result of anything like volition, yet nearly all of them are inexplicable on mechanical principles. Some of them at least are spontaneous motions of the plant or organism itself, due to some inherent power which is merely put in action by light, attraction, or other external influences."

I have already adverted to insectivorous plants, such as *Dionæa*. In such plants we have susceptibilities strangely like those of animals. An impression is made, and appropriate resulting actions ensue. Moreover, these actions do not take place without the occurrence of electrical changes similar to those which occur in muscular contraction. Hardly less noteworthy are the curious methods by which the roots of some plants seek moisture as if by instinct, or those by which the tendrils of certain climbers seek and find appropriate support, and having found it, cling to it by a pseudo-voluntary clasping, or, finally, those by which the little "Mother-of-a-thousand" explores surfaces for appropriate hollows in which to deposit her progeny.

Nevertheless, nothing in the shape of vegetable nervous or muscular tissue has been detected, and as structure and function necessarily vary together, it is impossible to attribute sensations, sense perceptions, instincts, or voluntary motions to plants, though the principle of individuation in each acts as in the unfelt psychoses of animals and harmonises its various life-processes.

The conception, then, which commended itself to the clear and certainly unbiassed Greek intellect of more than 2,000 years ago, that there are three orders of internal organic forces, or principles of individuation, namely, the rational, the animal, and the vegetal,[1] appears to me to be justified by the light of the science of our own day.

I come now to the bearing of these remarks on the science of biology generally.

Animals and plants may, as I have before said, be regarded either *statically*, by anatomy, or *dynamically*, by physiology.

Physiology, as usually understood, regards the properties of the ultimate morphological components of organisms, the powers of the various aggregations of such components, *i.e.* of the various "tissues" and the functions of the different special aggregations and arrangements of tissues which constitute "organs."

But as each living creature is a highly complex unity—both a unity of body and also a unity of force, or a synthesis of activities—it seems to me that we require a distinct kind of physiology to be devoted to the investigation of such syntheses of activities as exist in each kind of living creature. I mean to say that just as we have a physiology devoted to the several activities of the several organs, which activities are the functions of those organs, so we need a physiology specially directed to the 'physiology of the living body considered as one whole, that is, to the power which is the function, so to speak, of that whole, and of which the whole body, in its totality, is the organ.

In a word, we need a *physiology of the individual*. This science, however, needs a distinct appellation. I think an adequate one is not far to seek.

Such a line of inquiry may be followed up, whatever view be accepted as to the nature of those forces or activities which living creatures exhibit. But if we recognise, as I myself think our reason calls on us to recognise, the existence in each living being of such a "principle of individuation" as I have advocated the recognition of, then an inquiry into the total activity of any living being, considered as one whole, is tantamount to an

b "a physical state." Then a sensation and its physical accompaniment may be represented by the symbol $a + b$. But a physical state is itself but a state of consciousness with its objective correlate, and is, therefore, $a + b$. We thus get an equation infinitely more erroneous than $b = a + b$, because the b of the $a + b$ is itself ever again and again $a + b$.

[1] As when having gazed vacantly through a window we revert to the pages of a manuscript we may be writing and see there the spectra of the window bars we had before unconsciously seen. Here the effect on the organism must have been similar to what it would have been had we attended to it—*i.e.*, it was unfelt sensation.

[1] Difficult as it confessedly is to draw the dividing line between animals and plants, such difficulty is not inconsistent with the existence of a really profound difference between the two groups. That there should be a radical distinction of nature between two organisms, which distinction our senses nevertheless, more or less fail to distinguish, is a fact which on any view must be admitted, since animals of very different natures may be indistinguishable by us in the germ, and in the earlier stages of their development. The truth of this is practically supported by the late Mr. Lewes, who says (as to the difference between the protoplasms from which animals and plants respectively arise): "That critical differences must exist is proved by the divergence of the products. The vegetable cell is not the animal cell; and although both plants and animals have albumen, fibrine, and caseine, the *derivatives* of these are unlike. Horny substance, connective tissue, nerve tissue, chitine, biliverdine . . . and a variety of other products of evolution or of waste, never appear in plants; while the hydrocarbons abundant in plants are, with two or three exceptions, absent from animals. Such facts imply differences in elementary composition; and this result is further enforced by the fact that when the two seem to resemble, they are still different. The plant protoplasms form various cells, but never form a cartilage cell, or a nerve cell; fibres, but never a fibre of elastic tissue; tubes, but never a nerve tube; vessels, but never a vessel with muscular coatings; solid "skeletons," but always from an organic substance (*cellulose*), not from phosphates and carbonates. In no one character can we say that the plant and the animal are identical; we can only point throughout the two kingdoms to a great similarity accompanying a radical diversity."—"The Physical Basis of Mind," p. 129.

inquiry into the nature of its principle of individuation. Such an inquire becomes "*psychology*" in the widest and in the original signification of that term—it is the psychology of Aristotle.

Mr. Herbert Spencer has already made a great step towards reverting to this original use of the term, for he has made his "psychology" conterminous with the animal kingdom, having made it a history of the psychoses of animals. But the activities of plants must not be ignored. A science which should include the impressionability and reactions of a Rhizopod and exclude the far more striking impressionability and reactions of Venus's fly-trap, and of other insectivorous plants, the recognised number of which is greatly on the increase, must be a very partial and incomplete science. If psychology is to be extended (as I think Mr. Spencer is most rational in extending it) to the whole animal kingdom, it must be made to include the vegetable kingdom also. Psychology, thus understood, will be conterminous with the whole of biology, and will embrace one aspect of organic dynamics, while physiology will embrace the other.

PHYSIOLOGY will be devoted (as it is now) to the study of the activities of tissues, of organs, and of functions, *per se*, such, *e.g.*, as the function of nutrition as exhibited in all organism from the lowest plants to man, the functions of respiration, reproduction, irritability, sensation, locomotion, &c., similarly considered, as manifested in the whole series of organic forms in which such powers may show themselves.

PSYCHOLOGY will be devoted (according to its original conception) to the study of the activities of each living creature considered as one whole—to the form, modes, and conditions of nutrition and reproduction as they may coexist in any one plant; to these, as they may coexist with sensibility and motility in any kind of animal, and finally to the coexistence of all these with rationality as in man, and to the interactions and conditions of action of all these as existing in him, and here the science which corresponds to the most narrow and restricted sense of the word, psychology, *i.e.*, the subjective psychology of introspection, will find its place.

Psychology in the widest sense of the term, in its oldest and in what I believe will be its ultimate meaning, must necessarily be, as to its details, a science of the future. For just as physiology requires as a necessary, antecedent condition, a knowledge of anatomy—since we must know that organs *exist* before we investigate what they *do*—so psychology requires as a necessary, antecedent condition, an already advanced physiology. It requires it because we must be acquainted with the various functions before we can study their synthesis and interactions.

When, however, this study has advanced, one most important result of that advance will be a knowledge, more or less complete, of the innate powers of organisms, and therefore of their laws of variation. By the acquisition of such knowledge we shall be placed in a position whence we may advance, with some prospects of success, to investigate the problem of the "origin of species"—the biological problem of our century.

This reflection leads me back once more to my starting-point, the merits of the great French naturalist of the last century, whose views as to variation and as to animal psychosis, have enabled me to bring before you the questions on which I have presumed to enter. Buffon's claims on our esteem have, I think, been too much forgotten, and I rejoice in this opportunity of paying my debt of gratitude to him by recalling them to recollection. As to the questions which his words have suggested to me and upon which I have thus most imperfectly touched, the considerations I have ventured to offer may or may not commend themselves to your approval; but, at least, they are the result of not a few years of study and reflection, and I am persuaded they have consequences directly or indirectly affecting the whole field of biological inquiry, which belief has alone induced me to make so large a call upon your patience and your indulgent kindness.

NOTES

AMONGST other lectures announced for the coming Baden-Baden meeting of the German Association of Naturalists, to which we have not referred in our note last week, we may mention that at the opening of the first general meeting on September 18, Prof. Kussmaul, of Strasburg, will deliver a memorial address in memory of the late Dr. Benedict Stilling, of Cassel, the first secretary of last year's meeting. The second and third general meetings will take place on September 20 and 24 respectively, and will be partly occupied with the following lectures:—Prof. Ecker, of Freiburg, "On Lorenz Oken, in connection with the Centenary of his Birth;" Prof. Goltz, of Strasburg, "On the Heart;" Prof. Jaeger, of Stuttgart, "On Affections of the Mind." The sectional meetings will take place on September 19, 22, and 23. For these up to the present no less than seventy-six papers have been announced, comprising all domains of natural science and medicine. The following may be of more general interest:—"On the Colour Sense among the Ancients and among Modern Uncivilised Tribes," by Prof. Hartmann, of Berlin; "On the Injurious Effects of the Refuse of Factories, specially of Bleaching Works, with regard to Fish," by Dr. Weichelt, of Rufach; "On the Physiology of the Brain," by Prof. Goltz, of Strasburg; "On Sea Climates and Sea Voyages, from a Physiological and Pathological Point of View," by Dr. Faber, of Stuttgart; "On Crimes and Insanity," by Dr. Kornfeld, of Wohlau; "Experimental Lecture on the Brain," by Prof. Rüdinger, of Munich; "On the Present State of Animal Vaccination and the Corresponding Institutions in Germany, Holland, and Belgium," by Dr. Fürst, of Leipzig.

THE Sanitary Congress and Exhibition of the Sanitary Institute of Great Britain will this year be held at Croydon. Dr. Richardson, F.R.S., has accepted the office of President of the Congress, and a large and influential committee, of which Mr. John Corry is the chairman, has been formed. The Sanitary Congress is divided into three sections, viz.:—Section 1.—Sanitary Science and Preventive Medicine; president, Alfred Carpenter, M.D., London, J.P. Section 2.—Engineering and Sanitary Construction; president, Capt. Douglas Galton, R.E., C.B., F.R.S. Section 3.—Meteorology and Geology; president, G. J. Symons, F.R.S. Arrangements have also been made for one or more lectures, one of which will be delivered by Prof. Corfield.

THE Fourth Annual General Meeting of the Mineralogical Society of Great Britain and Ireland, to receive the Report of the Council, and elect Officers for the ensuing year, and for general business, will be held at the Freemasons' Hall, Surrey Street, Sheffield, on Friday, August 22, at 3 P.M. The following papers will be read:—"On the Production of Different Secondary Forms of Crystalline Minerals," by H. C. Sorby, F.R.S.; "New Scottish Minerals," by Prof. M. F. Heddle; "On some Cornish Serpentinous Rocks," by J. H. Collins, F.G.S.

THE Fifth Annual Conference of the Cryptogamic Society of Scotland will be held at Forres, on September 17 and following days. The programme of arrangements has been garnished with several not inappropriate quotations from Shakespeare, whose "Macbeth" is naturally suggested by Forres.

DR. JOHN M'KENDRICK, Professor of the Institutes of Medicine in Glasgow University, has been appointed Lecturer in Natural Science and Theology for Session 1879-80, under the Banchory Bequest, at Aberdeen Free Church College, in succession to Dr. Lauder Brunton.

WE regret to record the death of Sir Thomas Moncreiffe of Moncreiffe, Bart., President of the Perthshire Society of Natural Science, and late President of the Cryptogamic Society of Scotland. Sir Thomas was an enthusiastic entomologist and did much to foster and promote the study of natural history in Perthshire. Amongst the schemes which he had at heart was the establishment of an efficient local museum and other aids to the promotion of the study of science in Perth. He was a frequent contributor to the pages of the *Scottish Naturalist*, among his latest contributions being a catalogue of the lepidoptera observed within one square mile at Moncreiffe, which included no less than upwards of 600 species, and is valuable for the notes on

the habits and for the light thrown on the geographical distribution of the species in Britain. Sir Thomas, who was Vice-Lieutenant of Perthshire, died on August 16, in his fifty-seventh year.

THE death is announced of Dr. Immanuel Hermann von Fichte, formerly Professor of Philosophy at Bonn and Tübingen Universities, and son of the celebrated Jena professor. Dr. von Fichte was born at Jena in 1797, and died at Stuttgart on August 8 last.

THE fifth Russian Archæological Congress will be held at Tiflis in September, 1881, and will be specially devoted to the investigation of ancient monuments. A committee meeting will take place at Moscow in January, 1880, when the detailed programme of the Congress will be arranged.

IN one of the recently submerged coal mines in the Dux district (Bohemia) a remarkable phenomenon has occurred which Dr. Braumüller, an eminent Austrian mining engineer, describes. It appears that in the subterranean waters of the "Fortschritt" mine regular tides have been observed for the last six months. Both the Berlin and the Vienna Academies of Sciences, are devoting considerable attention to the strange phenomenon. A satisfactory explanation has, however, not yet been arrived at by either.

THE electric light has made its way to the highest hotel of Europe, *i.e.*, to the hotel which is situated at the greatest elevation above the sea-level. The "Engadiner Kulm" Hotel at St. Moritz, in the Upper Engadine, boasts of an elevation of 1,856 metres above the sea, and the proprietor announces that the establishment now possesses eight Jablochkoff lamps. A waterwheel is the motor of the electric machine feeding the lamps.

THE National Water-Supply Exhibition was inaugurated at the Alexandra Palace last Thursday by the Lord Mayor; Mr. Chadwick, C.B., Col. Bolton, Mr. Wanklyn, Prof. Seeley, and others interested in the water-supply question, were present at the luncheon. The exhibition, which covers a wide and varied field of appliances and products in connection with the supply and uses of water, is really interesting, and ought to attract the attention of visitors. We trust it will have the educational effect hoped for. It is intended to keep it open till the spring, and as the object is to collect information as well as to spread it, it is hoped that those who have any maps, or tables referring to water-supply, will send them. Information respecting the aims of the committee may be obtained from Mr. A. T. Atchison, M.A., 34, Great George Street, Westminster. From the remarks of Mr. Cross on Mr. Fawcett's motion last week, it would seem as if Government had determined to deal with this all-important question.

THE Giffard monster captive balloon burst on the 16th inst., a little before six o'clock, when a moderate wind was blowing from the south-east. It will be remembered that M. Henri Giffard placed his balloon in the hands of a company of uneducated aëronauts, who neglected to follow his advice, and for economy's sake left his balloon partly uninflated. The wind acting on the vacuum left in the lower part of the balloon, agitated the canvas in so extraordinary a manner that it gave way. It will not be restored this year, the season being too far advanced for the purpose.

THE French Academy of Meteorological Ascents made two successful experiments, one at St. Germain on the 9th inst., and the other at Cambrai, to test whether it was possible to prognosticate, with the help of pilot balloons, the path which the mounted aërostat would follow. The results were satisfactory. At St. Germain the wind was very light and uncertain, but at Cambrai the velocity was forty kilometres an hour. A competent colombophile had been placed in the car, and a number of carrier-pigeons were liberated from the balloon, and a narrative of the principal incidents of the journey was posted in the city before the aërial travellers had landed. The system had been explained by M. de Fonvielle in a lecture given in the morning in the town-hall.

THE correspondent of a Swiss paper warns collectors of antiquities to beware of fabricated specimens of articles purporting to belong to the age of bronze and to have been found among the remains of lake dwellings and in the beds of rivers. He says there is a regular manufactory of these things near the Lake of Bienne, and that bronze swords are being offered at 100f. each which are not worth as many centimes.

TWO streams of lava flowed on the 15th from Mount Vesuvius to the base of the cone. There was no eruption on the 16th.

M. MOREL FATRO, who is conducting some extensive explorations at the lacustrine station of Corcelettes, Canton Vaud, announces the discovery of a large canoe in an excellent state of preservation. It is formed of a single pine log 32 feet long and 2¾ feet wide; and though the stern is slightly damaged, the bow, which is carved and ornamented, is perfect. This interesting find will be placed in the museum of Lausanne, which now contains the richest collection of lacustrine relics in Europe.

THE new part of the *Transactions* of the Asiatic Society of Japan contains much interesting matter; the most important paper, however, is one on the transliteration of the Japanese Syllabary, by Mr. Ernest M. Satow, of H.M.'s Legation at Yedo, who has industriously applied himself to the study of the language for the past eighteen years, and is one of the greatest authorities on the subject. There are also two papers worthy of notice, the one on inscriptions in Shimabara and Amakusa, and the other on the foreign travel of modern Japanese adventurers.

A PARTY recently visiting the Daly River, North Australia, appear to have met with an alligator far larger than any hitherto seen. Nothing but the head was visible, but this is described as being about 4 feet in length and 2 feet 6 inches in width. On being fired at the monster disappeared, and the precise size of its body could not be ascertained.

IN a valley at the foot of the so-called Habichtswald, near Cassel, a short distance from the castle of Wilhelmshöhe, a new ferruginous mineral spring has been discovered. The water of the new spring belongs to the class of alkaline earthy iron-waters, and besides salts of iron, contains a great quantity of carbonate of lime. It strongly resembles the Schwalbach waters both in taste and composition.

THE Government of Western Australia has offered a reward for the discovery of new guano islands. Valuable deposits are believed to exist on the north coast between the Lacepedes and Camden harbour.

MR. WM. HUGHES'. "Outlines of Geology and Geological Notes of Ireland" has reached a third edition, which the author states has been almost rewritten. It contains a considerable number of illustrations. Gill and Son of Dublin are the publishers.

"THE Students' Catalogue of British Plants, arranged according to the Students' Flora of the British Isles, by Sir J. D. Hooker, C.B.," is the title of a useful list, compiled by the Rev. George Henslow, and published by Bateman, of Portland Town, London.

THE *Proceedings* of the Bristol Naturalists' Society contains as usual several excellent papers. Mr. Stoddart's papers on the geology of the Bristol coal field are continued; Mr. Bucknall contributes a list of the fungi of the Bristol district; Dr. Fripp an account of some experiments on insect hearing; Mr. A. E.

Hudd part 2 of a catalogue of the Lepidoptera of the Bristol district.

"SCIENCE Teaching in Living Nature, a Popular Introduction to the Study of Physiological Chemistry and Sanitary Science," is the title of a little volume by Mr. W. H. Watson, F.C.S., just published by Stanford.

THE additions to the Zoological Society's Gardens during the past week include two Diana Monkeys (*Cercopithecus diana*) from West Africa, presented by Mr. F. J. Crocker; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mr. C. F. S. Day; a Malbrouch Monkey (*Cercopithecus cynosurus*) from West Africa, presented by Miss Agnes Barker; a Black Stork (*Ciconia nigra*) from Jutland, presented by Prof. J. Reinhardt, F.M.Z.S.; a Rose-crested Cockatoo (*Cacatua moluccensis*) from Moluccas, presented by Miss Foster; fourteen Golden Tench (*Tinca vulgaris*, var.), presented by Lord Walsingham, F.Z.S.; a Common Buzzard (*Buteo vulgaris*), European, deposited; two Black-footed Penguins (*Spheniscus demersus*) from South Africa, purchased; two Crested Pigeons (*Ocyphaps lophotes*), two Geoffroy's Doves (*Peristera geoffroii*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

THE ELONGATED NEBULÆ.—The amateur provided with an equatorial of fair aperture and a parallel-wire micrometer might do good service by the accurate determination of the angles of position of the elongated or greatly-extended nebulæ, of which so far the number of reliable measures is but small, though such objects are pretty commonly distributed. The necessity for further observations in this direction is well illustrated by the note to No. 2501 of Sir John Herschel's General Catalogue = H. I. 94; H. made the nebula by one observation extended n. to s., by another nf. to sp., while two observations by Sir John Herschel agree in making it extended in the parallel; "Surely," he remarks, "it does not rotate?" D'Arrest ("Siderum Nebulosorum") merely says: "Circa directionem axis nihil annotatum fuit."

In 1874 Mr. Cleveland Abbe called attention to this subject, and in the *American Journal of Science and Arts*, January, 1875, has collected the approximate places of about sixty elongated nebulæ from Herschel's catalogue, and has appended formulæ by which the right ascension and declination of the poles of a very much extended nebula may be calculated. These formulæ he has applied to such measures or estimations, often rough ones, of the angles of position as were then published.

THE NEW BINARY STAR τ CYGNI.—This star, the duplicity of which was detected by Mr. A. G. Clark in October, 1874, with the 26-inch object-glass manufactured for Mr. McCormick, of Chicago, well deserves following up; in the $3\frac{1}{2}$ years to 1878·4, when measures were made by Mr. Burnham, the angle of position had retrograded 25°, with but little change of distance, though a slight decrease may be suspected. The components are about 4·5 and 8. Right ascension for 1880, 21h. 10m. 8s.; declination, 37° 32'. If the motion in angle has been equable since 1874, the position may now be about 140°.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

"Report of an Unusual Phenomenon Observed at Sea"

As the unusual phenomena observed in the Persian Gulf, described in NATURE, vol. xx. p. 291, has hitherto called forth no remarks, I venture to put forward a suggestion that may be of service in elucidating the matter.

First, I would observe that the so-called parallel waves were probably arcs of large concentric circles, whose common centre lay south-south-west of H.M.S. *Vulture's* first, and east of her last, position. The distance between these positions was about a knot and a half, therefore the vessel was never nearer this centre than about half a mile, and a short arc of a circle of this radius might well be deemed straight.

The accompanying diagram, drawn from the data, shows the position of the centre of disturbance, and of the luminous waves, with relation to the course of the ship, taking the above view, which I think is borne out by the character of the second series of luminous waves through which H.M.S. *Vulture* passed.

Most living creatures possessing phosphorescence have more

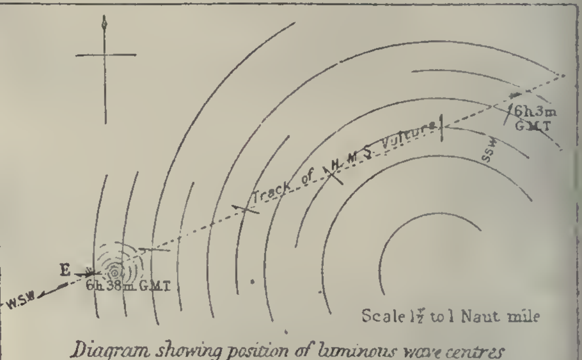


Diagram showing position of luminous wave centres

or less control over its display. In the case of the fire-fly, the light that one emits calls forth almost instantaneously answering flashes from others. No dweller in the tropics can have failed to observe the manner in which trees are lit up by the simultaneous flash of thousands of fire-flies, and the period of darkness that intervenes before the next flash. If then we consider the *Vulture* to have passed through a shoal (if I may so term it) of animalculæ, possessing the power of exhibiting phosphorescence intermittently, and exciting each other to do so, the impulse travelling from one to another at the rate of 125 feet a second, and the display of light to the dark interval bearing the ratio 1 to 3 (in time, $\frac{1}{4}$ of a second to $\frac{3}{4}$), we have accounted for the phenomena so far as the luminous waves are concerned.

What were the central disturbances that originated the action, it is impossible to say, though it is easy to imagine several causes of irritation, that would not have been detected by the simple observations taken on board the vessel.

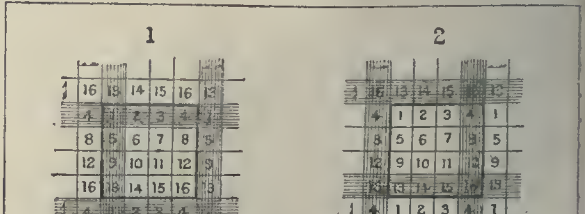


Diagram showing intersections of luminous waves.

The luminous waves of the smaller series "meeting the parallel waves from south-east did not cross, but appeared to obliterate each other at the moving point of contact." The above is difficult to explain, if the luminosity of the waves was obliterated at the actual intersections. It can however be readily shown that close to the intersections are spaces where the phosphorescence of the animalculæ would have to be displayed for twice as long a period as in other positions, and we have but to admit a want of energy to meet this call, and dark spaces will appear in each system of waves, immediately following the passage of the crossing wave.

This would certainly give the appearance of one wave obliterating the other.

A second diagram explains this simply. Here a portion of ocean is divided into numbered squares of 25 feet, and the advance of the 25′ luminous waves, 75′ apart is shown in two following positions. It will be seen that spaces numbered 4 and 13 fall successively under the impulses. Similarly, in the next 25′ advance of the waves, would all those numbered 12 and 15, and so on, the assumed dark spaces following in the wake of each intersection, as it pursues its diagonal course.

Beckenham, August 5 EDWARD H. PRINGLE

The Planet Jupiter

IN the bright zone south of the south equatorial belt may now be seen a strange and beautiful feature like a flame—red elliptical cloud surrounded by a brilliant white aureole. I first observed it near midnight on the 14th inst., when approaching the middle of its apparent course across the disk.

In November, 1869, Mr. Gledhill discovered an elliptical figure in the same zone, but it was dark, with an interior space bright and colourless.

Gledhill's No. 2 belt (*Ast. Register*, April, 1870), which was a most striking feature for some years, disappeared in 1874, re-appeared in May, 1875, again disappeared, and is now again faintly visible. It is *under* (north of) the north equatorial belt.

The south equatorial belt seems of a slate-blue, the north of a russet or dark red colour. The bright central space is crossed by dark, irregular bridges slanting from south-west to north-east—the invariable direction of all the oblique formations that I have ever remarked on Jupiter.

The north polar region seems occupied by a number of apparently close, narrow belts. The south has a pretty similar appearance, but the belts here are not so numerous nor so distinct. JOHN BIRMINGHAM

August 15

Twenty-nine Gleams of Sunshine, August 7, 8, 9, in Nine Hours

IN a paper, about weather, written by Mr. Ellis, of Greenwich Observatory, and published in NATURE, vol. xx. p. 313, mention is made of work done with an instrument for registering sunshine, which I contrived, got made, and gave to the Observatory. It consists of a glass sphere, a stand for it, and a metal bowl. The spherical surfaces have a common centre, and radii so measured that the focal cone of sunshine condensed by the glass is cut, by blackened cardboard fixed in the bowl, at the same distance, and at right angles, whatever the sun's position may be in the visible sky. The temperature near the point is at least 700° when the weather is clear. The sun's circular image describes a circle about the common centre, and it burns a trace on cardboard when the sun shines clearly. I can think of nothing better or simpler for the purpose of registering sunshine and counting clouds daily.

The inclosed printer's block was engraved in the focal cone of a cast glass sphere. The flat surface, blackened with shoe-blacking, was set roughly parallel to the plane of the equator, and the hot point was brought to bear upon it, at about 1 P.M. on August 7. Thus arranged the section of the cone is not circular, but is an ellipse, which is longer or shorter in proportion to the clearness of the atmosphere. The ellipse describes a circle on the boxwood plane. Hollows burned out by it print white, the surface left prints black. Clouds which crossed the sun's path may be counted between white oval spots. There are twenty-nine spots, the rest was cloud. In common weather parlance the morning of the 7th was "sunny," but the blue sky was veiled by a broken roof of thin detached clouds, moving eastward. They hindered heat waves. Between them were narrow clearer openings. When one of these passed the sun the cone of sunshine burned the block instantly. Afternoon about two, the broken cloud roof mended, rain fell, and the evening was dark and sunless. The night was wet. The morning of the 8th was "cloudy." Not a patch of blue sky was visible big enough to make a pair of breeches for a Dutchman. But the weather "looked as if it might clear up." The sun was "trying to shine." Birds sung notes which forecast a fine day,

2 P.M. 10 A.M.

and the day was "fine." The official forecast was "cloudy" and the day was very cloudy. The sun was seen "wading through mist" at intervals. At 10 A.M. one brighter gleam burned a mark; but that was all the bright sunshine that reached this garden. For a great depth the air was full of water condensed into the shape of the burning glass. Each spherical drop acted on sunshine as the bulb of a spirit thermometer acts—in "absorbing heat," in stopping, refracting, and dispersing waves of solar radiation. There was more shade than sunshine at the ground. The morning of the 9th was sunny, hazy, and cloudy. But large patches of very pale blue sky were visible. Birds foretold a fine day, and they were true prophets. The sun's image came on the block at 9.30 A.M., and it was set carefully at 10, and left till 2 P.M. The air was "thick" all day, the blue of the sky was very pale, and the sunshine "watery." The record shows when brighter gleams occurred during the time of exposure. About noon, as commonly happens, clouds gathered and hid the sun. The brightest time came after noon.

This bit of "thermographic wood engraving" may give readers in brighter climes some notion of the dismal cloudy sky of this abnormal English summer. There has not been a cloudless day since the year began. The blue of the sky never has been the dark indigo of Egyptian and Californian skies.

The cause of this excess of cloud I take to be excess of solar radiation, and consequent evaporation to our westward. Condensation has been in proportion along the European Atlantic coasts, where the ground was chilled by a late and severe winter, and has been little warmed and dried since by sunshine. According to casual and official weather reports, public and private, the heat has been great in America, on the Atlantic, in Spain, in the south of France, in Eastern Russia, in Egypt, and on the Red Sea. The sun shines fiercely upon the ground beyond the edge of a great cloud which has come persistently from the Western Ocean to overshadow our islands, and to drench and batter them with rain and hailstones. Our shadow is the result of sunshine. Our grass is green, our health is good, our gardens are gay in spite of the clouds, or because of them.

Believing in this theory I am going eastward in search of brighter weather, and I send this record of watery sunshine for your acceptance before I start. J. F. CAMPBELL

Niddry Lodge, Kensington, August 9

Electric Clocks

THE various contrivances for electric clocks all depend on producing contacts with the pendulum, which is confessedly undesirable; and they nearly all produce these contacts when the pendulum is at rest at the highest point, which is the worst position.

There seems no reason why a pendulum with a coil-bob traversing over a short permanent magnet, as is usual, should not be independent of contacts. While descending the lower part of the stroke it reaches the magnet, and a current is thus excited in the coil, which is conveyed out at the knife-edges and works a switch; this sends a battery current through the coil for a short period while the pendulum is beginning its ascent, and so drives it forwards by repulsion from the magnet. The same process is repeated in the back stroke. The interval between the production of the excited current and the battery current, and also the duration of the battery current, may be regulated by a small pendulum whose single swing is equal to the interval, and which is liberated by the excited current. The details are so easily

arranged that it is scarcely worth while to particularise them. Of course the battery current thus liberated by the excited current could be used for controlling other clocks.

The effect on the pendulum is thus restricted to the quicker parts of its swing; and consists of slightly retarding the descent, and accelerating the ascent, apart from all mechanical friction or contacts. Thus each action is produced at the most suitable time.

Possibly a pendulum cutting off heat rays from a thermopile might thus work a switch, and be even less affected than by producing an excited current in the coil-bob, as proposed above.

Bromley, Kent W. M. FLINDERS PETRIE

Did Flowers Exist during the Carboniferous Epoch?

NOTICING in your pages under the above heading a discussion on *fossil* butterflies and moths, &c., and being struck with the deep interest taken in the question as evidenced by the letter of the Rev. A. E. Eaton (vol. xx. p. 315), I thought that I would ask for a very small space for an intercommunication which may forward investigation.

I have in my collection what appears to me to be a butterfly (using the word without any regard to scientific nomenclature), as a carbonaceous impress on a piece of shale from the Slievardagh coal-field, Tipperary; and by way of contributing my mite towards an inquiry which it gives me pleasure to find so earnestly pursued, I shall be happy to forward the specimen for examination to any of the scientific gentlemen interested who will furnish me his address, or in turn to as many as it will be convenient so to accommodate, on *condition that the specimen be returned to me in good order and without unreasonable delay*.

I may be allowed to add that I have no sympathy whatever with the discussion in its present bearings.

Earlshill Colliery, Thurles, August 7 WILLIAM MORRIS

"Euclid and His Modern Rivals"

MR. DODGSON thinks "it worth while to point out a mistake made in the paragraph about Mr. Morell's book" (NATURE, vol. xx. p. 240). In the words "the thing not being capable of proof," the "thing" referred to is Mr. Morell's assertion that "the perimeter *MDQRSTM* is less than the perimeter *MPQRSTM*," which is not necessarily true, and of course is incapable of proof. Surely this assertion, which I quote two lines before "thing" occurs, is its grammatical antecedent? *You* refer it back to the theorem itself, which Mr. Morell is trying to prove—a theorem which *is* true and easily proved." I gladly accept Mr. Dodgson's statement, which is, if I remember rightly—for I am here far away from Mr. Dodgson's book—perfectly correct—and apologise for having inaccurately represented his meaning.

THE WRITER OF THE NOTICE OF "EUCLID AND HIS MODERN RIVALS"

Penzance, August 8

SOCIETIES AND ACADEMIES

LONDON

Entomological Society, August 6.—J. W. Dunning, M.A., F.L.S., vice-president, in the chair.—Mr. Philips exhibited living specimens (both sexes) of *Spercheus emarginatus*, taken at West Ham.—Mr. Stainton exhibited, on behalf of Mr. Grigg, of Bristol, larvæ of *Rösterstammia erxlebella*, a genus of which the larva had hitherto been unknown.—Miss Ormerod read a paper entitled "Sugar-cane Borers of British Guiana," and exhibited specimens of the insects referred to, in different stages of development. The exhibition was made on behalf of the Colonial Company, who were anxious to receive any information as to available and practical methods of dealing with these insects. Mr. Distant stated that the circumstances were almost the same on the sugar estates in the Straits Settlements at Malacca, where burning the infected canes was the usual remedy applied.—Mr. Swinton communicated a note with reference to the urticating properties of the larva of *Liparis auriflua*, and a communication was also received from Mr. McLachlan on correlation of mutilation in the larva with deformity in the imago, being the substance of a notice by M. Melise on the subject in the *Compte Rendu* of the Belgian Entomological Society.

VIENNA

Imperial Academy of Sciences, June 13.—On two new *Notodelphyides*, with remarks on some features in the organisation of this family, by Herr Kerschner.—On the yearly period of the insect fauna of Austria-Hungary, No. IV., by Herr Fritsch.—On the motion of plates between the electrodes of a Holtz machine, by Herr Doubrava.—On the perfect pentagon, by Herr Kohn.—On the specific viscosity of a liquid and its relation to chemical constitution, by Prof. Pribram and Dr. Handl.—On the crystalline form and optical properties of isodulcite, by Prof. Urba.—Determination of the inclination from oscillation of a magnetic bar, by Prof. Pscheidl.—The Ferdinandsbrunn spring at Marienbad in Bohemia, by Prof. Gintl.

PARIS

Academy of Sciences, August 11.—M. Daubrée in the chair.—Experimental researches on the erosive action of highly compressed and highly heated gases, and their application to the history of meteors and bolides, by M. Daubrée.—On the acids generated when the crude acids resulting from the saponification of neutral fats are distilled in a current of super-heated steam, by MM. A. Cahours and Demarçay.—Reply to M. Berthelot's note on hydrate of chloral, by M. Wurtz.—On the generation of electricity by the Rays, by M. Ch. Robin.—On the eclipse of July 19 last, observed at Marseilles, by M. J. Janssen.—Second and last observation by M. A. Ledieu, on M. Bouquet de la Grye's paper on atmospheric waves.—M. Palacciano was elected correspondent in the Medical and Surgical Section of the Academy, in place of the late M. Lebert.—On some properties of quadratic forms, by M. Poincaré.—On hydrodynamical principles and the application of these principles, by M. G. Clère.—On the formation of nitric ether in wine, by M. Romanet du Caillaud.—On the distillation of liquids under the influence of static electricity, by M. D. Gernez.—On Ampère's currents, by M. Trève.—On the vapour densities of some organic substances with high boiling points, by M. L. Troost.—On the density of chlorine at high temperatures, by M. Ad. Lieben.—On the synthesis of phenol glucoside, and of ortho-formylglucoside or helicine, by M. A. Michael.—On a combination of chromic acid with fluoride of potassium, by M. L. Varenne.—On the production of crystallised metallic oxides by means of cyanide of potassium, by the same.—On the identity of hydrate of diisoprene and of caoutchine with terpene.—On the conservation of green fodder, by M. G. Lechartier.—On the latent irritation of the muscle in frogs and in man, both in the healthy and the diseased states, by M. M. Mendelssohn.—On the electric irritation of the apex of the heart, by MM. Dastre and Morat.—On the action of the poison from *Bethrops jararacussu*, by MM. Couty and de Lacerda.—Causes of the alteration of animal temperature produced by ether, chloral and chloroform, by M. Arloing.—On the structure of the cephalic ganglions of insects, by M. W. Wagner.—On the rot of the vine, by M. A. Millardet.—On the temperature of the month of July, 1879, by M. E. Renou.—On the history of perfect numbers, by M. L. Hugo.

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THURSDAY, AUGUST 28, 1879

THE BRITISH ASSOCIATION AT SHEFFIELD

THE Forty-ninth Annual Meeting of the British Association must be reckoned one of decided success. The large number and variety of papers read in the sections, the excellence of presidential and sectional addresses and of evening discourses, the satisfaction afforded by local and general arrangements, and not least by the favourable meteorological conditions prevailing during the week, have all contributed to make the Sheffield gathering one to be remembered with pleasure.

The president, Dr. Allman, had the misfortune at the outset to be suffering from a severe cold, which made the delivery of his admirable address somewhat laboured and painful. But his audience proved sympathetic and even enthusiastic; and the printed copies of his address have been eagerly demanded on all hands. Whether prepared to agree with the dictum that irritability as a property of matter is the one grand characteristic phenomenon of all living things, or not, none will dispute the extreme ability and lucidity of the address.

Surprise has been expressed in some quarters that Prof. Allman should have ventured to found such momentous speculations, even partly, on so unstable a basis as "Bathybius," and in this connection Prof. Huxley's remarks in supporting the vote of thanks to the president are well worth reproducing:—

"It is my business to recollect, on the present occasion, that I have come to praise Cæsar, and not to bury him under any mountain of talk of my own; and I will, therefore, not venture to dwell upon any of those very large topics upon which he has dwelt with so much fairness, with so much judgment, and with so remarkable a knowledge of the existing information respecting them. But I will ask you to allow me to say one word rather on my own account, in order to prevent a misconception which, I think, might arise, and which I should regret if it did arise. I dare say that no one in this room, who has attained middle life, has been so fortunate as to reach that age without being obliged now and then to look back upon some acquaintance, or, it may be, intimate ally of his youth, who has not quite verified the promises of that youth. Nay, let us suppose he has done the very reverse, and has become a very questionable sort of character, and a person whose acquaintance does not seem quite so desirable as it was in those young days; his way and yours have separated; you have not heard much about him; but eminently trustworthy persons have assured you he has done this, that, or the other; and is more or less of a black sheep, in fact. The president, in the early part of his address, alluded to a certain thing—I hardly know whether I ought to call it thing or not—of which he gave you the name Bathybius, and he stated, with perfect justice, that I had brought that thing into notice; at any rate, indeed, I christened it, and I am, in a certain sense, its earliest friend. For some time after that interesting Bathybius was launched into the world, a number of admirable persons took the little thing by the hand, and made very much of it, and, as the president was good enough to tell you, I am glad to be able to repeat and verify all the statements, as a matter of fact, which I had ventured to make about it. And so things went on, and I thought my young friend Bathybius would turn out a credit to me. But I am sorry to say, as time has gone on, he has not altogether verified the promise of his youth. In the first place, as the president told you, he could not be found when he was wanted; and in the second place, when he was found, all sorts of things were said about him. Indeed, I regret to be obliged to tell you that some persons of severe minds went so far as to say that he was nothing but simply a gelatinous precipitate of slime, which had carried down organic matter. If that is so, I am very sorry for it, for whoever else may have joined in this error, I am undoubtedly primarily responsible for it. But I do not know at this present time of my own knowledge how the matter stands. Nothing would please me more than to investigate the matter afresh in the way it ought to be investigated, but that would require a voyage of some time, and the investigation of this thing in its native haunts is a kind of work for which, for many years past, I have had no opportunity, and which I do not think I am very likely to enjoy again. Therefore my own judgment is in an absolute state of suspension about it. I can only warn you what has been said about this friend of mine, but I cannot say whether what is said is justified or not. But I feel very happy about the matter. There is one thing about us men of science, and that is no one who has the greatest prejudice against science can venture to say that we ever endeavour to conceal each other's mistakes. And, therefore, I rest in the most entire and complete confidence that if this should happen to be a blunder of mine, some day or other it will be carefully exposed by somebody. But pray let me remind you whether all this story about Bathybius be right or wrong makes not the smallest difference to the general argument of the remarkable address put before you to-night. All the statements your president has made are just as true, as profoundly true, as if this little eccentric Bathybius did not exist at all. I congratulate you upon having had the opportunity of listening to an address so profound, so exhaustive in all respects, and so remarkable, and I ask you to join in the vote of thanks which has just been proposed."

A clever metrical skit on the president's address by an eminent geologist caused considerable amusement to those who had the privilege of seeing it.

The first of the evening discourses was by Mr. W. Crookes, F.R.S., upon Radiant Matter, and was illustrated by a unique display of those exquisite experiments on the movements of molecules in high vacua which have recently attracted so much attention. Nothing could exceed the beauty or brilliance of the experiments, which were made on a scale sufficiently large to be visible to an audience of nearly two thousand persons. The final experiment of allowing the air to enter through a microscopic hole into an exhausted radiometer bulb of large dimensions afforded the lecturer the means of making a most telling illustration of the enormous figures which must be employed in calculating the numbers of molecules contained in a small space.

The second discourse, by Prof. Ray Lankester, F.R.S., on Degeneration, was an attempt to establish that the laws of organic evolution may work downwards as well as upwards, reducing a free crustacean to a barnacle, or a vertebrate to an ascidian: a view which may at least claim some antiquity on its side since it is but an expansion of the Koran legend of Moses and the men of the Dead Sea who degenerated into apes.

The Saturday evening lecture by Mr. W. E. Ayrton, upon the Transmission of Power by Electricity, was listened to by a crowded audience, a large proportion of whom were working men, and was illustrated experimentally on a large scale.

In the sections much good work has been done. Section A (Mathematics and Physics) has been remarkable for the absence of great names, yet it has been well attended on the whole. A paper on Etherspheres as a *vera causa* in Natural Philosophy, by Rev. S. Earnshaw, has deservedly attracted attention as giving forth a most ingenious speculation on the mechanics, so to speak, of

the relation between matter and energy. Mr. Gordon exhibited a number of beautiful and newly-devised instruments for his researches on electrical induction, and M. Janssen on two occasions brought forward some of the further results gleaned in the field of astronomical physics, in which his name is so justly renowned. A paper by Prof. H. A. Newton, of Yale College, on the Direct Motion of Periodic Comets of Short Period, presented many points of the highest interest, and is a most valuable contribution to theoretical physical astronomy. The President of the Section, Mr. Johnstone Stoney, F.R.S., communicated several valuable papers on Molecular Physics and on Spectroscopy. Dr. Graham reported some excellent observations on Atmospheric Electricity from Madeira; and Prof. S. P. Thompson dealt with the Retardation of Phase of Vibrations in the Telephone, and showed an instrument called the pseudophone, for producing acoustic illusions.

In the Department of Mathematics, which sat on Saturday morning, several important communications were made.

In Section B (Chemistry) Prof. Dewar presided, and contributed several papers. His address was solely concerned with industrial chemistry, and does not seem to have contained much of novelty. Naturally, metallurgy has claimed prominence in this industrial centre, and chemical visitors have had ample opportunity of visiting the various works in the neighbourhood. Amongst the establishments which have thus drawn large numbers of visitors are the Bessemer steel works of Messrs. Steel and Tozer, and the electroplating factory of Messrs. Walker and Hall.

The Biologists and Anatomists have kept Section D a centre of attraction. The addresses of Prof. Mivart and Dr. Pye-Smith are each admirable; and the quiet but effective sarcasm with which the latter exposed the fallacies of anti-vivisection agitators drew hearty applause. Dr. Tylor's address to the Department of Anthropology was no less interesting, and was listened to attentively, as were Sir J. Lubbock on Fruit and Seeds, and Dr. Crichton-Browne on the Influence of Domestication on Brain-Growth.

Section E (Geography) has been favoured by the presence of several distinguished travellers, Commander Cameron, Major Serpa Pinto, and Count S. de Brazza, all African explorers of note, having given papers. Afghan and Zululand have furnished themes of burning discussion to this Section.

The Economic Section appears to have taken a new lease of active life, and has seldom presented more animation.

In the Mechanical Section the subjects of Friction at High Velocities, the Patent Laws, Hot Air Blast, and Electric Lighting, have claimed attention, and M. Bergeron explained the principles of Francy's Fireless Locomotive.

In spite of the drawback of bad and inconvenient streets and poor hotel accommodation, the Association has been fairly accommodated, and the reception accorded has been most hearty. The Mayor, the Master Cutler, and many other citizens of prominence, have been unremitting in their efforts; and the praises of Yorkshire hospitality are loudly sung. The reception of the Mayor at the *soirée* of Thursday evening in the Cutlers' Hall was very brilliant. The scientific *soirée* of Tuesday evening was no less successful, though the pleasure of the occasion was at one moment threatened by an unfortunate difference of opinion between local and general authorities on the subject of dancing, concerning which, however, a compromise was subsequently arranged.

The Mayor's banquet on Saturday evening was attended by about 340 guests, and was highly successful. Mr. Mundella, in replying to the toast of the Houses of Parliament, proposed by Dr. Odling, deplored the lack of sympathy between Parliament and science, and declared that he had sat up late so often in support of the Ancient Monuments Bill of Sir J. Lubbock, that he had almost become an ancient monument himself. The Archbishop of York responded for the Clergy, and General Thuillier and Commander Cameron for the Army and Navy. Dr. Haughton, of Dublin, was as amusing as ever in proposing the health of the Presidents of Sections.

Many little excursions have been organised during the week to places of interest. The Saturday excursions were eminently successful, and the Thursday excursions, including expeditions to the Peak, Castleton, &c., were very popular and largely attended.

The reports of the sectional proceedings in the local papers seem to us unusually meagre, though the space devoted to the Association both in provincial and in London papers becomes each year increasingly great. The *Times* alone this year has had several leaders on the Association generally, as well as on the principal addresses, and it is gratifying to notice the decided improvement not only in the knowledge displayed in these articles, but also in the attitude of the leading paper towards science. In a somewhat hysterical article on Prof. Allman's address, the *Observer* of last Sunday seems to forget that science has all sorts of followers, and that the real workers rarely come before the public. Notwithstanding the apparently complete ignorance of the writer in the *Observer* as to what science really is, we cannot help agreeing with much that he says as to the present condition of the Association, and the urgent need of reform in its method of work, if it is not rapidly to degenerate into a "scientific garden party."

It is gratifying to notice the change of attitude of the Archbishop of York towards science and its followers, to judge both from the sermon of Sunday and his speech at the Mayor's banquet. He evidently no longer regards the foremost of the workers in science as emissaries of the "Evil One," but rather as fellow-workers with "the Church" for the highest good of humanity. To those who heard, on a Sunday, years ago, Prof. Huxley's famous address in Edinburgh, on the Physical Basis of Life, and the introductory references to an address delivered a few days previously by the Archbishop, this change of attitude must be very significant.

A committee was appointed last year for the consideration of the organisation of the Natural History Museum in connection with its removal to South Kensington. A memorial was forwarded by the Council to the First Lord of the Treasury, who could not receive a deputation, but who forwarded a reply.

The memorial referred to the fact that the Royal Commission on Science had recommended that the occasion of the removal of the collections to South Kensington New Museum be taken advantage of to effect a change in the official administration of that division of the British Museum; that a director of the collections and a board of visitors be appointed. The memorialists stated that notwithstanding these expressions of opinion, an Act had been passed by Parliament for the removal of the collection to South Kensington, but no change had been made in the mode of the administration. They called attention to the fact that it was at variance with the recommendations of the Royal Commissioners, and urged upon her Majesty's Government to take steps to carry out these recommendations, as the administration of the collections was of the utmort importance to the future progress of natural history in this country.

Capt. Douglas Galton read at the meeting of Council the reply received from the Treasury, which states that—

"My Lords, while fully agreeing with you, that the question of the administration of these collections is one of the utmost importance as regards the future progress of natural history in this country, are also of opinion that there is nothing which, on a point requiring so much con-

sideration, calls for instant decision. They think that the reasons which led them in 1877 to constitute the present Meteorological Council, rather than to create a new Government department, are not without weight in regard to displacing the trustees of the British Museum. My Lords do not intend to propose to Parliament any immediate change in the management of these collections, and they would be glad to find that the reasons which had led to the recommendations of the Royal Commission had been found to be capable of being met without any serious departure from the principles of a more or less indepenent trust."

It was generally agreed that this reply was very disappointing, and after remarks from various Members of Council, Prof. Huxley drew attention to the paragraph in the Treasury's letter where the manner in which the meteorological body had been dealt with, was mentioned, and said that to make any such comparison would be simply ludicrous. The Meteorological Committee was composed of the greatest experts in meteorology within the three kingdoms. He desired to speak with every respect of such distinguished persons as the trustees of the British Museum, but he could not say that they stood in the same position to natural history. There was no point of resemblance in referring to the placing of meteorology in the hands of a meteorological council. If the Treasury was prepared to place the management of the natural history department of the British Museum in the hands of a body which corresponded in zoology to what meteorology was in the meteorological council, that was an exceedingly intelligent proposition, and the General Committee should consider it carefully before they said anything against it, for it came very much to what the committee was advocating. As the Treasury appeared to be still fluid and mobile, it might be well that the General Committee replied to the letter, saying that the Treasury themselves suggested a basis on which they could construct an administration which would be perfectly satisfactory to the British Association, and therefore it would be perfectly agreeable to all round.

The sum received for tickets this year has been 1,425*l*.

Next year the Association meets at Swansea, when Prof. Ramsay will be President. In 1881 the Association celebrates its jubilee at York—a year behind time.

The following grants have been made :—

	£
A—Mathematics and Physics	
Lodge, Dr.—New Form of High Insulation Key	10
Adams, Prof.—Standard of White Light	20
Everett, Prof.—Underground Temperature	10
Joule, Dr.—Determination of the Mechanical Equivalent of Heat	50
Thomson, Sir W.—Elasticity of wire	50
Glaisher, Mr.—Luminous Meteors	30
Darwin, Mr. G. H.—Lunar Disturbance of Gravity ...	30
Sylvester, Prof.—Fundamental Invariants	50
Perry, Mr. J.—Laws of Water Friction	20
Ayrton, Mr. W. E.—Specific Inductive Capacity of Sprengel Vacuum	20
Haughton, Rev. Prof.—Completion of Tables of Sun-heat Co-efficients	50
Forbes, Prof. G.—Instrument for Detection of Fire-damp in Mines	10
Thomson, Mr. J. M.—Inductive Capacity of Crystals and Paraffines	25
B—Chemistry	
Dewar, Prof.—Spectrum Analysis	10
Wallace, Dr.—Development of Light from Coal-gas ...	10
C—Geology	
Duncan, Prof. P. M.—Report on Carboniferous Polyzoa	10
Adam, Prof. A. L.—Caves of South Ireland	10
Seeley, Prof.—Viviparous Nature of Ichthyosaurus	10
Evans, Mr. John—Kent's Cavern Exploration	50
Evans, Mr. John.—Geological Record	100
Williamson, Prof. W. C.—Miocene Flora of the Basalt of North Ireland	15
Hull, Prof.—Underground Waters of Permian Formation	5
D—Biology	£
Pye-Smith, Dr.—Elimination of Nitrogen by Bodily Exercise	50
Lane-Fox, General M.—Anthropological Notes	20
Stainton, Mr.—Record of Zoological Literature	100
Foster, Dr. M.—Table at Zoological Station at Naples ...	75
Gamgee, Dr. A.—Investigation of the Geology and Zoology of Mexico	50
Lubbock, Sir J.—Excavations at Port Stewart	15
F—Statistics and Economic Science	
Farr, Dr.—Anthropometry	50
G—Mechanics	
Bramwell, Dr.—Patent Laws	5
	£960

SECTION A

MATHEMATICAL AND PHYSICAL

Opening Address by G. Johnstone Stoney, M.A., F.R.S., Secretary to the Queen's University in Ireland

In order that we may understand the present position of natural science upon the earth, we must remember that the universe is in itself one great whole, which includes minds no less than bodies, for thought is as much a phenomenon of what really exists as motion. But though the universe be but one, man with his limited powers is unable to treat it as such, but has to push his investigation of nature when and where he can. Thus have arisen many sciences which were at first quite isolated. Their separate condition is a mark of the feebleness of our powers of investigation. Their gradual convergence, and especially where any complete contact can be established between them, is the mark that our advancing knowledge is penetrating deeper.

That there are many sciences of nature, instead of one science of nature, has its relation, then, to human imperfection. But the coalescence of sciences has commenced, and is steadily taking place ; magnetism is no longer isolated from electricity, nor light from heat, nor the power of thinking from the condition of the brain. In all such cases we have got nearer to understanding what is really going on in natnre. There are already many such achievements of science, but nevertheless it remains true that human powers of investigation are so narrow, and the use we have made of them up to the present is so short of what we may reasonably look for in the future, that the sciences of nature are still many, and most of them stand lamentably aloof from one another.

We find, then, in the present passing condition of our knowledge, one group of sciences which investigate the phenomena of consciousness, another distinct group of the biological sciences, and a third, the group of the physical sciences. These are all but parts of the one great investigation of nature, but for the present they exist almost disconnected, as separate provinces of human inquiry.

After remarking on the complication of the Biological Sciences Prof. Stoney said :—

In the rest of the study of nature we are not embarrassed by the phenomena of life, and many mysteries therefore stand aside out of our path. Here lies the domain of the physical sciences. It is here that the mind of man has best been able to cope with the realities of the Universe, and in which its greatest achievements have been effected. It is here that exact reasoning finds a predominant place.

The process of investigation in the exact sciences is fundamentally one in all cases. It has been well described by Mill in the Third Book of his Logic. Nevertheless it is notorious that minds which are well fitted for some branches of physical inquiry, find difficulty—sometimes insuperable difficulty—in pursuing others. It is not every eminent mathematician who would have made an equally good chemist, or *vice versâ*. This is because there exists a practical distinction separating the investigations of exact science into two well-marked classes when they are viewed, not as they are in themselves, but in their relation to the powers of us, human beings. I refer to the distinction between the experimental method or the method of observation, on the one hand, and the deductive method or the method of reasoning, on the other. All valid investigations in exact science appeal to what can be directly perceived, and all lead to a conclusion which can be reasoned out from it ; but there are some of these investigations in which the main difficulty consists in

making the appeal to the senses, and there are others in which the main difficulty lies in the process of reasoning.

To contend with these difficulties successfully requires very different qualities of mind and body. In experimental science the powers principally called into requisition are readiness and closeness of observation, dexterity in manipulation, skill in devising expedients, accuracy in making adjustments, and great patience. It also requires that the investigator should have an accurate memory of what else he has witnessed resembling the phenomenon under observation, that he should be quick to detect every point of agreement and difference that can be perceived, and be skilful to select those which are significant and to employ them as materials for prevision to guide his further proceedings. But the strain on the reasoning powers is generally less, often of trifling amount. The question is put to Nature, and it is Nature usually that gives the bulk of the answer. The most striking monument of splendid achievements by the experimental method of investigation unaided by the deductive method is to be found in the science of chemistry.

An equally typical instance of the power of the deductive method is the science of mechanics. This science, which has sunk deeper into the secrets of Nature than any other science, and which is the science towards which all other physical sciences are at present more or less gravitating, is essentially deductive. There is little or no difficulty about its fundamental data. They are facts of Nature, so patent to all men, and so indelibly implanted in human conception, that some persons have supposed that we have an intuitive perception of them. But, while the materials from which the mind is to work are thus easily obtained, it has taxed to the utmost the reasoning powers of understandings like Newton's to evolve the few consequences of them which are already known, and the investigator has to call to his assistance every aid to prolonged consecutive thought which mathematicians can devise.

In grappling with the problems of Nature we are seldom allowed the choice of the method of investigation we shall employ. This is commonly settled for us and not by us. Where we cannot advance without further information, we must make further observations, *i.e.*, we must employ the experimental method, the appeal *ad experientiam;* where we cannot advance without understanding better what the information we possess really amounts to, we must employ the deductive method. . . .

After referring to Kirchhoff's investigations as an example Prof. Stoney said:—Wherever data are known exactly, there inferences from these data, however remote, may be depended upon as corresponding with what actually occurs in nature. And if, in such cases, the mind of man has proved equal to the task of drawing inferences which can effectually grapple with the problems he finds around him in the universe—which is, alas, as yet but too seldom—then will the deductive method, our plummet, explore depths in the great ocean of existence which our anchors of experiment could not have reached.

The distinction which is here made between deductive and experimental investigations would have no place in a logical system. But it has direct reference to human convenience, and derives its importance from this circumstance. It is obvious, too, that an investigation may partake of both characters—that it may require all the powers of the scientific observer to get at the facts, or even to appreciate them, and all the resources of the mathematician to elicit the consequences of them. For instance, on beginning his electrical studies the student of nature must master a mixed experimental and deductive inquiry to get at the elementary fact that free electricity resides either at or outside the surfaces of conductors; and he must engage in a further inquiry, and one only within the reach of a trained mind, to deduce from this the law of the inverse square. And, again, no full appreciation or even intelligent use of the common electrostatic and electrodynamic measures, which he meets at the threshold of his electrical studies, is within the reach of the mere experimentalist or of the mere theorist. And if this treacherous ground lies before the immature student at his entrance, what shall we say of the bogs he struggles into as he advances? We are perpetually meeting with inquiries of this mixed character in electricity and some of the other physical sciences, but they are comparatively rare in either mechanics or chemistry, and none that is difficult lies in the path of the beginner. How many students are there who are made to slur over the above and a multitude of similar difficulties, and who are told that they are learning science, when in fact what they are really learning is the pernicious habit of being content to see nature through a fog or through other men's mental eyes.

In mechanics valuable progress can be made by the mere mathematician, the student of deductive science; and in chemistry similar progress can be made by the mere experimentalist. Of all the physical sciences these are the most purely deductive and the most purely experimental. What I desire particularly to invite attention to is that the two great methods of investigation may best be acquired in these two sciences, and that for a really sound grasp of the remaining physical sciences, and especially with a view to further advance in physical science, a command of both methods of investigation is essential. But then, to bestow this invaluable power on the scientific student, the great science of mechanics must be presented to him in its own true form, and not degraded by the vile art of avoiding the legitimate use of the infinitesimal calculus in order to comply with the ill-judged conditions of some examination; and our practical chemistry must be made something more scientific than instruction in the lucrative art of the analyst.

We must bear in mind, too, that either method of investigation may be misapplied, and that this is a risk carefully to be guarded against. The deductive method, when misapplied, lands us in speculation, the experimental method becomes empiricism; and it so happens that the sciences of mechanics and chemistry are not only monuments of the power of the two great methods of investigation, but instructive examples of their weakness also. For in chemistry scarce any attempt at prolonged reasoning, carrying us by any lengthened flight to a distance from the experiments, can be relied on. The result has seldom risen to anything better than speculation. And on the other hand, in mechanics conclusions which depend on experiments only are empirical; that is, they are deficient in accuracy and their relation to the other phenomena of the science is left in darkness. Here, then, we find in these two sciences not only how strong these two methods of investigation are, but how weak they may become if misapplied. . . .

I have sought to show that it is in the study of mechanics and the practice of chemistry that the two great methods of investigation may best be acquired. In them they may be studied separately, by steps of graduated difficulty, and with a superabundance of materials; and each of them supplies the necessary cautions with respect to the method which is all-powerful in the other. No scientific man is really equipped for the pursuits in which both methods have to be employed till he has separately acquired a grasp of each. For it is only then that he will be armed against the errors which lead so many to mistake empiricism on the one hand and speculation on the other for solid science, or to underrate solid science, mistaking it for speculation. Nor is it only in his scientific occupations that he will derive benefit from this training. All exact reasoning, whether in science or in common life, belongs to these great divisions; and in the numberless instances in which we must be satisfied with reasoning which falls short of being exact, our only safety lies in having by the practice of exact reasoning, both deductive and experimental, attained to that intellectual tact and caution which alone will enable us to handle with safety the sharp and slippery tool. It is thus I am persuaded that a sound judgment with regard to truth may best be acquired by man or woman; and soundness of judgment is the noblest endowment of man's understanding, just as veracity is first among his virtues.

SECTION D

BIOLOGY

Department of Anatomy and Physiology

ADDRESS BY P. H. PYE-SMITH, B.A., M.D., VICE-PRESIDENT OF THE SECTION

THE Association to which we belong seeks to advance Natural Science, that is, accurate knowledge of the material world, by the following means:—

First.—By bringing together men who are engaged in the various fields of science indicated by our several sections, by promoting friendship between them, by giving opportunity for discussion on points of difference, by encouraging obscure but genuine labourers with the applause of the leaders whom they have learnt to venerate, and by fostering that feeling of respect for other branches of science, that knowledge of and interest in their progress, which chiefly marks the liberality of scientific study.

Secondly.—The Association provides funds, which, though

small in amount, are great in worth, from the mode of their distribution; and serve in a limited degree as an encouragement, though not an endowment, of research. One proof of the value of this method of subsidising unremunerative work by small grants distributed by the master workmen themselves is given by the fact that the sum of 4,000*l.* annually contributed by the Government of the United Kingdom for the endowment of research is distributed on the same plan by a Committee of the Royal Society.

The Third most important aim of our Association is, "to obtain a more general attention to the objects and methods of science, and the removal of any disadvantages of a public kind which impede its progress." It is for this reason that the Association travels from one to another of the great centres of population and intellectual activity of the kingdom. Local scientific societies and local museums are generated and regenerated in its path, local industries are for a time raised to a higher level than that of money-getting, and every artisan may learn how his own craft depends upon knowledge of the facts of nature, and how he forms part of the great system of applied science which is subduing the earth and all its powers to the use of man. We wish to make science popular, not by deceiving idlers into the belief that any thorough knowledge can be easy, but by exciting interest in its objects and appreciation of its methods. In the popular evening lectures you will hear those who are best qualified to speak upon their several subjects, not preaching with the dry austerity of a pedant, but bringing their own enthusiasm to kindle a contagious fire in those who hear them.

Endeavouring to aid in these objects, I shall in this introductory address offer you some considerations upon the bearing of biology in general, and anatomy and physiology in particular, upon national well-being and public interests.

Biology is the science of the structure, the functions, the distribution, and the succession in time of all living beings. If the proper study of mankind be man, he has learnt late in the inquiry that he can only understand himself by recognising that he is but one in the vast network of organic creation; that intelligible human anatomy must be based upon comparative anatomy; that human physiology can only be approached as a branch of general physiology, and that even the humblest mould or seaweed may furnish help to explain the most important problems of human existence.

The branch of physiology which is concerned with man, not as an individual, but a family, the branch which we now call Anthropology, is obviously related to practical politics, and it was not without reason that the late illustrious pathologist Rokitansky began a speech in the Upper House of the Austrian Parliament on the autonomy of the Bohemian nation with the words, "The question really is whether the doctrine of Darwin be true or no."

In another department, that of psychology, the physiology of the nervous system has already thrown more light upon the mysterious phenomena of consciousness than was gained by the acutest minds of all ages without the help of anatomical methods.

All the improvements of modern agriculture and stock-breeding rest upon more or less fully understood scientific principles, and the more perfectly the results have been first worked out in the laboratory the more safe and the more lucrative will be their application in the field.[1]

Still more important is the relation of physiology to the national health. The commonplaces of hygiene which are now, one may be thankful to say, taught, if not practised, in almost every schoolroom and factory in England, are the direct results of the abstruse researches of Boyle and Priestley, of Lavoisier and Pasteur. Ages of experience did not teach mankind the value of fresh air, or the innocence of clean water. Indeed, I have myself heard astonishment expressed by a German professor at the peculiar immunity with which English skins will bear the daily and unstinted application of soap and water.

If the art of keeping a community in health is but the application of plain physiological laws, it is no less true that the art of restoring the health, curative as distinct from preventive medicine, rests upon the same basis. In former days the physician was one who recognised what he called the disease of his patient, who referred to his books of precedents as a lawyer to his statutes, and who prescribed a proper remedy to cast out the disease. We now know that disease is, as the name implies, a purely subjective conception. The disease of a host is the health of the parasite, and we cure a human sufferer by poisoning the animals or plants which interfere with his comfort. The same changes which in the old man are the natural steps of decay, the absence of which after a certain age would be truly pathological, are the cause of acute disease in the young. Pathology has no laws distinct from those of physiology.

When these now obvious considerations are thoroughly understood, it clearly follows that all "systems of medicine" are in their very nature condemned. All that the art of medicine can do is to apply a knowledge of natural laws, of mechanics, and of hydrostatics, of botany and zoology, of chemistry and electricity, of the behaviour of living cells and organs when subjected to the influence of heat and of cold, of acids and alkalies, of alcohols and ethers, of narcotics and stimulants, so as to modify certain deviations from ordinary structure and function which are productive of pain, or discomfort, or death. It is, therefore, plain that rational medicine, or keeping right and setting right the human body, must rest upon a knowledge of its structure and its actions, just as a steam-engine or a watch cannot be mended upon general principles, but only by one who is familiar with their construction and working, and who can detect the source of their irregularity.

An objector may say:—"Admitting that medicine is an art, it is a purely empirical art. You cannot detect the origin of many of the maladies which you are yet able to cure; your best remedies have not been obtained by scientific experiment, but by chance, observation, and accumulated experience; and if you doctors would give more time to practical therapeutics, that is, to finding out what is good for the several aches and pains we complain of, you would spend your time better than in abstruse researches into microscopic anatomy or the properties of a dead frog's muscle."

The answer to the objection is an appeal to fact. For centuries so called observation and experience left medicine in the condition it occupied at the end of the seventeenth century. The progress of therapeutics is to be marked, not by the labours of "practical men," (who, by the way, are of all the most theoretical, only that their theories are wrong), but by the, at first sight, unconnected studies of Descartes and Newton, of Hooke and Grew, of Lavoisier and Davy and Volta, of Marshall Hall and Johannes Müller.

The history of science proves that unconnected, unsystematic, inaccurate observations are worth nothing. For untold ages men have had ample opportunities of studying the indications of the weather, and have felt the utmost desire to obtain a knowledge of what they portend. Yet it may fairly be said that nothing had been done to the purpose, until combined and systematic observations were made in this country and America. The fact is, that popular notions do not rest upon experience or observation. They rest, with scarcely an exception, upon metaphysical theories. In dealing with uneducated persons, both of the lower and higher ranks, physicians find abundance of theories as to the nature and the origin of disease, and of suggestions as to its cure. The only thing which would be of value is what we can scarcely ever get, an accurate observation of what they see and feel. Every fallacy of popular medicine, every solemn medical imposture, is the ghost of some long defunct doctrine of the schools. Therefore it is that common experience is almost absolutely useless in practical arts. They, without exception, depend for their progress upon the advance of science, that is, upon methodical, continuous, and scrupulously accurate observations and experiments.

Many important advances in the practice of medicine have been gained by direct and intentional experiments instituted with a therapeutical object. Such was the Hunterian operation for aneurism, the process of skin-grafting, and subperiosteal operations; such was the administration of chloroform and the introduction of nitrite of amyl, chloral hydrate, and carbolic acid. Such direct experiments still go on, and among them deserve mention for the skill and the untiring patience with which they were carried out, those investigations upon the action of various drugs on the secretion of bile for which we are indebted to Prof. Rutherford and his coadjutors. Even apparently accidental discoveries were not made accidentally. Hundreds of country surgeons must have been familiar with the cow-pox, and have seen examples of the immunity it conferred from the more terrible variola, but he who discovered vaccination was no falsely called practical man. He was a man of science, the

[1] I need only refer to the fruitful labours of Mr. Lawes and Dr. Gilbert in this direction.

friend of Hunter and of Cavendish, an anatomist and natural philosopher. The fruits of Jenner's discovery are spread over the whole earth. This humble village doctor has saved more lives than the most glorious conqueror destroyed, but his name is little honoured, and the only monument to his memory has been banished from association with vulgar kings and skilful homicides to an obscure corner of the great city, where his only homage is the health and beauty of the children who play around his statue.

But after all, it is not so much by direct and immediate contributions to the art of healing that physiology has vindicated her ancient title of the institutes of medicine, numerous and important as these contributions have been. It is still more by the scientific spirit which has transformed the empty learning so justly ridiculed by Molière and Le Sage into the practical efficiency of modern surgery. Let me give an instance of what I mean. The notion of measuring the temperature of the body is simple enough, and the rough observation that in inflammation the temperature is raised had led to the various terms by which it was denoted in ancient medicine, and to numberless theories now happily forgotten. But although the thermometer was well known, and had been applied by many scientific physicians, notably by De Haen, by Dr. John Davy, and by Sir Benjamin Brodie, yet the practical value of the clinical thermometer which now every practitioner carries in his pocket was not understood until the other day. Those only who had been trained in accurate physical and physiological investigations, who had learned the worse than uselessness of "rough observation," were able to see the enormous importance of clinical thermometry. This most practical of modern improvements in medicine would never have been dreamt of by "practical men": we owe it to the scientific training of German laboratories.

If physiology is of such great national importance, if the necessity of experimental research is so vital to the common national wealth, to agriculture and commerce, to health and well-being, ought not its well-ascertained results to be taught in our common schools, and its prosecution directly encouraged by the State?

There is no question of the great importance of children being taught the rudimentary laws of health, the bodily evils of dirt and sloth and vice, the excellence of temperance, the danger of the first inroads of disease. Such teaching, now broadcast in many excellent manuals as "The Personal Care of Health," by the late Dr. Parkes, and Dr. Bridges' "Catechism of Health," is no doubt extremely valuable, and happily is daily more and more diffused. But when beyond the direct utility of such knowledge, we attempt to make it an intellectual discipline, there are, I conceive, difficulties which will always prevent even elementary physiology from forming an important part of general education. First, there is the practical difficulty of the necessary dissections, next the impossibility of making physiology demonstrative, and thirdly, the abstruseness of the subject. It is impossible to have even an elementary knowledge of the laws of living beings without a very considerable familiarity with those of physics and of chemistry, and even in medical schools it requires all our efforts to prevent it degenerating into a mere dogmatic statement of results, or a laboured repetition of hearsay statements. As an intellectual discipline, for facility of demonstration, for the simplicity of the objects, their beauty and interest, their associations with the green lanes and broad moors of England, with the poetry of *Cymbeline* and *Lycidas*, with fairy tales and local folk-lore—Botany is to my mind the branch of natural science which is above all others to be chosen where one only can be taught. Next in importance I would place elementary physics, the knowledge of the simplest laws of masses at rest and in motion, of heat and light. Its great recommendations are its precision, its constant and useful illustrations in daily life, the interest it gives to the handicrafts and manufactures in which so large a number of English boys and girls are busied, and the necessity of such knowledge as the first step in acquiring all other natural sciences.

First, then, I would that every Sheffield girl should love flowers with the deep and abiding affection of familiar knowledge, and that every Sheffield lad should know every common plant in your beautiful woods and find his purest pleasure on the heights of Bell Hagg and the broad expanse of Stanage Moor. And next I would that your workmen and workboys should know so much of mechanics that they may take an intelligent pride in your vast factories, and that in some of them may be awakened the genius to which we trust to repeat in future generations the national services of Arkwright, and Watt, and Stevenson.

With regard to the endowment of research in biology, I must confess that I should be sorry to see it undertaken by government funds. That such investigations are of public interest, that they are difficult and expensive, and that at present they languish for want of adequate support, is all true. But this country is not so poor, nor our countrymen so wanting in public spirit, that we need appeal to the national purse to supply every ascertained want. Great as is the national importance of science, the nation is more important still; and even if that were the alternative, I would rather that we should indefinitely continue dependent on Germany for our knowledge than give up the local energy, the unofficial zeal which has made England what she is. Far better for the strength and the civilisation of the nation that a thousand pounds were raised every year for the endowment of unremunerative researches in this wealthy town of Sheffield than that ten thousand were paid you by a paternal monarch or an enlightened department.

But surely there is no need for us to go to Parliament for such sums as we require. In the first place, scientific men themselves show a good example of not asking before they give. There is the modest sum which we raise in this Association, there are the funds for helping research of the Royal Society, the Chemical Society, the British Medical Association, the Iron and Steel Institute, the Whitworth Scholarships. Next we have the resources of our Universities, which have scarcely begun to apply themselves to the task. I need do no more than allude to the Cavendish Laboratory, or to the Physiological School at Cambridge, where a simple college tutor, of rare ability, and of still more rare sympathy and energy, has in ten years, achieved results which we need not shrink from comparing with those of the great continental laboratories. The magnificent Museum of Anatomy, maintained by the College of Surgeons almost entirely out of their own funds, is another instance of private care for science to which we find no parallel abroad; and the Zoological Society wisely spends a large part of its income in prosecuting comparative anatomy, and in publishing its beautifully illustrated memoirs.

But besides the efforts of scientific bodies and the wealth of our national Universities, we may surely look to the public spirit of ancient companies and corporations to do something for the cause of science. In the middle ages our country was covered with parish churches by private munificence; in the sixteenth century most of our public and grammar schools were endowed; in later times our great religious and charitable societies were founded. May we not hope that, before the close of the present century, the discriminating knowledge which alone prevents gifts of money from being a curse instead of a blessing to a community, may lead to the establishment of libraries, and museums, and laboratories by universities and towns, which shall bear comparison, I will not say with those of Paris, or Leipsic, or Bonn, but with the poorer but scarcely less distinguished schools of Heidelberg and Göttingen, of Würzburg and of Utrecht?

Where we have institutions already under government control and patronage, let them be maintained as efficiently and liberally as possible. The British Museum, and its library, the Royal Observatory at Greenwich, and the Royal Gardens at Kew (happily preserved for the present from the short-sighted eagerness of those who would destroy their scientific value), these are great national institutions of which we are justly proud. Successive Governments will have enough to do to maintain their efficiency and to guard them from incompetent interference.

Whatever may be thought of the duty of the State directly to encourage the pursuit of animal and vegetable physiology, one would have supposed that at least what diplomatists call a benevolent neutrality, would be shown to a pursuit so labourious and costly, which demands trained workmen and the devotion of a lifetime, which is so important for the national wealth and health, and which, by reason, by experience, and by testimony, we know to be the only guarantee for advance in the various branches of the healing art. Why is it then that institutions which owe nothing to government assistance, and men who spend their time and talents in self-denying and unremunerative service for the public good, are not suffered to pursue their beneficent work in peace?

You know that certain persons who profess to be shocked by the methods of physiological research have succeeded in placing

this branch of science under as great disabilities as that sense of humour would allow, which so often redeems British ignorance from its most mischievous results.

The method that has given rise to so much excitement is the performance of experiments upon living animals. Now, if this were injurious to the greatest good of the greatest number of the community, or if freedom to perform these experiments interfered with the freedom of other persons to abstain from them, or if such experiments were forbidden by any religious or moral authority, by the Ten Commandments, or by Mr. Matthew Arnold, of course they must be given up; but equally, of course, the science of physiology must also come to a stop, and the farmer, the cattle-breeder, and the physician must be content with such knowledge or such ignorance as he at present possesses. I know it has been asserted that the science of the functions of living organs is quite independent of experiment upon living organs. But this is said by the same persons who have denied that the art of setting right the functions of the body when they go wrong has anything to do with the knowledge of what those functions are.

If you could be persuaded that chemistry can make progress without retorts and balances, that a geologist's hammer is a useless incumbrance, or that engineers can build bridges just as well by the rule of thumb as by the knowledge gained in a workshop, then you might believe that physiology also is independent of experiment.

It is absurd to object to the difficulties of the research or even the contradictory results sometimes obtained. The functions of a muscle or a gland are more complicated than those of water or gas, and their investigation needs greater skill, more caution and more frequent repetition. Imperfect experiments can lead to nothing but error; criticism from other physiologists, or from scientific men experinced in other branches of research, is not wanting and is always welcome. But vague assertion that further progress is impossible by the very means which have led to all our present knowledge, coming from those who "who are not of our school"—or any school, is undeserving of serious notice.

The real contention of course is a moral one, that we ought to relinquish the advantage of all experiments which are accompanied with pain to the creature experimented on. The botanist may serve his plants as he pleases, and even the animal physiologist may cut, or starve, or poison all sentient organisms which happen not to possess a backbone, and he may try experiments with all backboned animals, including himself and his friends, so long as they do not hurt, but that must be the limit. On the most extreme humanitarian views no objection can be made to experiments upon animals in a state of insensibility to pain, and as these constitute, happily, the vast majority of physiological experiments, the question is narrowed to comparatively restricted limits. Is it wrong to inflict painful experiments upon animals for the sake of science? In the absence of any authority to appeal to, we can but judge of the matter by analogy. Now it has been the practice of all mankind, and is still allowed by the common consent both of law and feeling, that we should destroy by more or less painful means, that we should enslave and force to work, and mutilate by painful operations, and hunt to death, and wound, and lacerate, and torture the brute creation for the following objects:—for our own self-preservation, as when we offer a reward for the killing of tigers and snakes in India; for our comfort as when we poison or otherwise destroy internal parasites, and vermin, and rats, and rabbits. Our safety, our food, our convenience, our wealth, or our amusement: all these objects have been and are regarded by the great mass of mankind, and are held by the laws of every civilised country, to be sufficiently important to justify the infliction of pain or death upon animals in whatever numbers may be necessary. The only restriction which Christian morality or in certain cases recent legislation imposes upon such practises is, that no more pain shall be inflicted than is necessary for the object in view. Killing or hurting domestic animals when moved by passion or by the horrible delight which some depraved natures feel in the act of inflicting pain was until lately the only recognised transgression against the law of England. I trust I need not say that it is only under such restrictions that physiologists desire to work.[1] Any one who would inflict a single pang beyond what is necessary for a scientific object, or would by carelessness fail to take due care of the animals he has to deal with, would be justly amenable to public reprobation. And, remember it is within these limits that the whole controversy lies, for after a long and patient examination of all that could be said by our accusers, the Royal Commission which was nominated for the purpose unanimously reported that in this country at least scientific experiments upon animals are free from abuse.

What is deliberately asserted is that within the restrictions which all humane persons impose upon themselves, it is lawful to inflict pain or death upon animals for profit or for sport, for money or for pastime; that property and sport are in England sacred things; but that the practises which they justify are unjustifiable when pursued with the object of increasing human knowledge or of relieving human suffering.

Of those persons who answer that they consider vivisection for the sake of sport to be almost as detestable as vivisection for the sake of duty, I would only ask first that they should deal impartially with both offences, and secondly that since in the one case their opinions are opposed to the practice of genteel society, and in the other to the convictions of all who are qualified to judge, they should at least contemplate the possibility of being mistaken. Putting the question of field sports altogether aside, you know perfectly well that in every village in England an extremely painful mutilation is constantly performed upon domestic animals in no registered laboratory, under no anæsthetics, and with no object but the convenience and profit of the owner. You remember how when an epidemic threatened the destruction of valuable property, every booby peer now eager to stop, so far as in him lay, the advance of knowledge, was no less eager to have carried out at the public expense any slaughter and any experiments, painful or otherwise, which would save his pocket.

But you will say: all this seems reasonable enough; but if so, how do you account for the prejudice against you, what has induced so many amiable and otherwise sane persons to join in the outcry against physiology?

First, I answer, it is due to the most frequent cause of folly—Ignorance. Many persons supposed to be educated are so destitute of the most ordinary conceptions of natural science that they do not understand the necessity for experiments. So little do they appreciate the difference between formal knowledge and real knowledge, that a distinguished statesman once assured me that he would as soon have his leg set by a man who had gained what he called his knowledge from books, as by one who had "walked the hospitals." Next, there is the vulgar dislike of whatever is not obviously and immediately useful. When knowledge for its own sake is in question, those of the baser sort are always ready to cry with equal ignorance of literature and of science, "*cui bono?*"

In another class of persons, less ignorant and less stupid than these two, opposition to physiological experiments appears to spring from what may fairly be stigmatised as Sentiment, that is to say, excitable, rather than deep feeling, uncontrolled by reason. People first gratify their fancy by calling cats and dogs our fellow creatures, which, in one sense, undoubtedly they are, and then, by the familiar fallacy of an ambiguous middle term, argue that it is cruel to put our fellow creatures to pain; or, as some would add, to reduce them to slavery, or to use them in any way for our own, rather than their good. Such persons compel their fellow creatures to drag them through the streets, they eat their fellow creatures when sufficiently vivisected to be palatable, and then find philosophical excuses for those who kill their fellow creatures for fun. But they are properly shocked when their fellow creatures are hurt or killed for the benefit of mankind. Such persons have been accused of feminine weakness; but I must say that I have never found an intelligent woman who could not see the rights of the case when fairly explained to her, whereas I have met a few men who on this, as in other matters, consistently refuse to give up to argument the notions which were formed by prejudice.

This sentiment is, I admit, the degradation of just feeling. To many unaffectedly compassionate hearts there is a peculiar pang in thinking of suffering which is deliberately inflicted, with only the justification of duty, instead of the excuse of ignorance or passion. They see in the helplessness of the dumb animals an appeal for pity, almost like that of childhood, and are justly indignant with the selfish cruelty so often exercised upon them. All honour to the efforts which have banished so many cruel sports from England; all honour to the Society which seeks to prevent cruelty to animals. If it can

[1] They are, in fact, the very limits that were put on record by this Association long before the agitation against physiology began. See Report for 1871, p. 144.

point to any additional means by which the sufferings of animals in the cause of science can be diminished, we shall be anxious to adopt them. If it can point to any abuse in one of our laboratories, we will hasten to correct it. This society has honourably declared that they know of none. That physiologists have been heedless, or even callous, in their experiments upon animals in past times, when men were strangely insensible even to human suffering, or in countries where a healthy result of Christian civilisation has not yet been seen in habitual gentleness to animals, I need not deny. Such cases have been eagerly sought and sometimes most unfairly judged. Only lately a learned body felt itself not strong enough to retain the admittedly invaluable services of an eminent foreigner, who had once admitted that when absorbed in scientific and beneficent researches he lost sight of any pain that might be inflicted.[1] Is not this the very excuse which is held valid in the case of sport? Doubtless we ought to be ever mindful of every branch of duty, but such occasional forgetfulness does not show hardness of heart. It is an excusable weakness for a student of medicine to shudder or to faint at the sight of blood, but he learns that this merely physical sensibility becomes selfish and mischievous if indulged: he is taught to suppress all such exhibition of emotion, and to let it stimulate without paralysing his efforts to relieve. But no one surely would think the hysterical youth more truly humane than the surgeon whose compassion is shown in the very firmness with which he inflicts a temporary pain for an ultimate good.

I have hitherto rested the whole argument upon the lawfulness of inflicting pain and death upon the lower animals for the sake of science and humanity, but as a matter of fact I may again assure those who, while assenting to the justice of the plea, yet shrink from what it may involve, that the great majority of experiments upon animals are rendered painless, and that the remainder are mostly those experiments which are most immediately and directly subservient to medical art, and happily even these are generally productive rather of discomfort than of pain. Let me give you an example of such a vivisection, far more painful than the immense majority of those of the laboratory. Suppose a country surgeon were sent for late at night to some case of urgent peril; knowing that his ride is for life or death, and unsparing of himself or his horse, he rides him to the utmost limits of endurance, and beyond: who would not applaud the action? Those only who appear deliberately to believe that our life is worth less than that of many sparrows, those legislators only who look forward to the time when wars will cease, not because of human slaughter, of devastated homes, of all the horrors which the world has endured for centuries, but because of the cruelties to which the horses in the artillery are subjected. We, who are familiar with human suffering and sorrow, which our knowledge is all too feeble to prevent, best understand how in testing some new remedy on a less precious fellow creature than a man, one who is truly humane may be tempted to forget the comparatively trivial suffering of a rabbit or a frog.

But some enthusiastic opponent will say, "I cannot pretend to doubt that these experiments are in every sense of the word useful, but we ought not to purchase the benefit they confer by inflicting pain upon innocent creatures. I would sign a petition to-morrow to put down all field sports by law, I would allow no operation upon domestic animals, and I will abstain from all animal food until I am certain that I can eat creatures which have been killed without suffering pain. But if I were lying at the point of death, and you brought an animal to my bedside and assured me that by putting it to pain my life would be saved, I would refuse to purchase it on such cruel terms." We may hope that the excellent person who made this heroic profession would in the hour of trial be better advised, but if not we may surely reply, "Right reverend sir, you are the best judge of the value of your own life, and if you think proper to sacrifice it to the comfort of a guinea-pig we must submit to the loss with such resignation as we can muster; but when you say that in obedience to this silly whim you will let your dearest friend suffer, allow the sacrifice of the most important life, and forbid those studies which have already rescued multitudes from deformity and misery and death, then those of us who have to do with the real responsibilities of life, and on whom presses the awful sense of impotence to which our defective science too often leaves us, answer that we too have duties to fulfil, and to the best of our power we mean conscientiously to fulfil them.

There is, I fear, another reason which animates much of the opposition to physiological experiments. It is nothing else than aversion from the methods and the results of science. It may be that an excuse for this dislike has been furnished by the pretence of false science, and the arrogance of much even which is true. But surely, no reasonable creature, from such trivial irritation, can deliberately wish to check the progress of accurate knowledge by observation and experiment. There are, indeed, some who, fearing (as I think prudently) that, "while a little philosophy inclineth men to atheism, depth in philosophy bringeth men's mind's about to religion," and desiring to subject the human mind to a bondage as hard and more degrading than that of mediæval Rome, would gladly call off interest from the unremunerative labours which are prompted only by the thirst for knowledge and faith in the possibility of learning more and more of the divine order of the world, to pursuits which bring obvious and material utility. There are those again, who, fearing (as I think foolishly) that increasing knowledge of this divine order will lower our admiration of its beauty, or that the better a man understands the laws of God the more likely he is to break them, have an unfeigned dislike for natural science in general, and for biology in particular. They repeat over again the error of which the Dominican friars, with far greater excuse, were guilty when they imprisoned Galileo. If any such are here, may I venture to tell them—in quietness and in confidence is your strength: the vast fabric of Christian morals is in no danger of being overturned by the discovery of a new chemical method in the laboratory, or of a hitherto undescribed animalcule. If noisy attacks are made in the injured name of science, you have only to wait, and you will see these attacks repelled by the true leaders of science themselves, or, at the worst, by the next generation. But if, leaving your secure fortress of defence, you come down with your rhetoric and your sentiments, your *petitio principii*, your *ignoratio elenchi*, and all your familiar fallacies and tropes, thinking that with such weapons you can meet, on their own ground, men who have spent their lives in the study of science, then no wonder if you suffer grievous defeat. Happy for you if you learn, like another discomfited pilgrim, to betake yourselves to another "weapon."

But I imagine that some of my audience are saying: "This defence would have been necessary before the Royal Commission made their report; but when that was made, and affirmed the necessity of physiological experiments, and the groundlessness of accusations of cruelty against physiologists, when an act was passed which licenses physiological laboratories, under the very restrictions which you had already imposed upon yourselves, may we not regard the controversy as closed, and the result as satisfactory?"

I answer that I have taken up your time with this defence of physiological experiments partly because I would fain help, however feebly, in the enlightenment of the public conscience, but also because the result of recent legislation is *not* satisfactory.

Science does not work readily in fetters. A system of licences and certificates, numerous and complicated, obtained with trouble and delay, and revocable at the will of a Minister who may, by the accidents of party, be at any time amenable to anti-scientific influences, such a system adds serious difficulties to those already in the way of experiments.

Suppose, as an illustration, that certain persons opposed on various grounds to learning, and especially hostile to Greek, had attacked the study of Plato. They would point out the danger of modern ladies becoming as well read in his writings as was Lady Jane Grey. They would show that the laxity of modern manners was coincident with the popularity of the "Symposium" and that the notorious increase of infanticide was the result of the teaching of the "Republic." Associations for the total suppression of Plato would be formed, with hired advocates, and anonymous letters, and "leaflets," spreading a knowledge of his most objectionable passages. Scholars would be threatened with eternal punishment, and schoolmasters with the withdrawal of their pupils. Then a royal commission would be appointed—a great Latin scholar, a Whig and a Tory statesman (who, having taken a B.Sc. degree at Oxford would be impartially ignorant of Greek) the

[1] Fortunately, Dr. Klein, whose researches in microscopic anatomy and pathology are so well known and appreciated, knows that he retains the confidence and respect of his scientific brethren, and we hope that his honourable connection with the largest school of medicine in London, will strengthen other and closer ties in binding him to England.

most intelligent despiser of Plato who could be found, the master of a grammar school on the modern side, and (perhaps the most efficient of all) a lawyer, who knew nothing about Greek but hated cant. This commission would take evidence that the Platonic writings were not all immoral, that they had been quoted with approval by Fathers of the Church, that they were of great importance to literature and philosophy, and even to the elucidation of the Sacred Writings. It would also be proved that the Platonic Dialogues were far less immoral than multitudes of other widely circulated books, or than a French novel which one of the royal commissioners happened to be reading, and, lastly, that the morals of Greek scholars, and of clergymen who had read Plato at college, were not obviously degraded below those of other people. On the other hand, witnesess would depose that a knowledge of Plato was of no consequence to a student of philosophy; that if it were, the text was in so corrupt a condition that no two scholars agreed as to a single chapter, and that, after all, philosophy was of no practical use, least of all to clergymen. Others would affirm that though they had never read a line of him, they knew that his style was as vicious as his sentiments; and perhaps some cross-grained scholar might be found who, having once edited a play of Euripides, would declare that all studies in Greek literature ought to be restricted to the tragedians, and that for his part he had never opened any other authors and had never felt the want of them.

At last the commission would report that there was no question of the value of the works of Plato, that it would be mischievous and impracticable to prohibit their study, and that there was no evidence that schoolmasters habitually chose the least edifying passages as lessons for boys. Then what is called a compromise would be made. It would be enacted that Plato might be read, but only in colleges annually licensed for that purpose; that every one wishing to read must have a general certificate signed by certain professors, and setting forth his object, also to be renewed every year; and that special certificates might be severally obtained for reading certain excepted dialogues, for copying from them, for publishing them, or, in rare cases, for translating them.

However reasonably such a system might be administered, who can doubt the result would be a diminution of the number of scholars, and a check to the progress of learning?

Now this is what legislation has done for physiological experiments. The Act [39 and 40 Victoria] was hastily drawn and hurriedly discussed; for noble lords and honourable gentlemen who had been taught from childhood to vivisect for unscientific purposes were eager to hurry off to their own merry vivisections, for which they were ready provided with licence and certificates. And it works as might be expected. Some shrink from seeing their names figure in disreputable newspapers, and receiving more or less savagely abusive anonymous letters. Others have no laboratories, and find difficulty in licensing their houses. Others are refused the certificates they require.

In one case two thoroughly qualified men were anxious to carry out an important investigation on the treatment of snake-bites. They procured venomous snakes from a distance, and applied for the special certificates necessary. Considerable delay ensued; various objections were raised, and set at rest; and at last all the certificates were obtained; but meantime the snakes had died.

I must apologise for having detained you so long. The whole history of this controversy is melancholy but instructive.

To those of my audience who wish well to science, I hope that I may have made more clear the grounds on which vivisection is necessary and right, and thus fulfilled one of the chief objects of the Association—"to obtain the removal of any disadvantage of a public kind which impedes the progress of science."

To those working physiologists who have honoured me by their presence I would express the assurance that they have the confidence and the gratitude of the medical profession, witnesses at once competent and impartial, who know the difficulties and the value of such labours; and as to present discouragements, looking back to the obstacles which so long retarded the progress of our kindred science, anatomy, I may say

O passi graviora, dabit Deus his quoque finem.

When, in the earliest years of the Royal Society, Sir Christopher Wren and Dr. Lower made those experiments on transfusion of blood which have at last proved so beneficent, there were not wanting shallow witlings who scoffed at their researches. It was of them that Cowley wrote with a just indignation—

> Whoever would deposed Truth advance
> Into the throne usurped from it,
> Must feel at first the blows of ignorance
> And the sharp points of envious wit.

You have at least escaped the latter penalty.

> Dishonour fall on those
> Who would to laughter or to scorn expose
> So virtuous and so noble a design,
> So human for its use, for knowledge so divine!

You wish your calumniators no greater dishonour than failure to do mischief. You wish for yourselves no other reward than "the wages of going on."

Department of Anthropology

ADDRESS BY EDWARD B. TYLOR, D.C.L., F.R.S.

IN surveying modern scientific opinion, the student is often reminded of a doctrine proclaimed in the ancient hymns of the Zend-Avesta, that of *Zrvâna akarana*, or "endless time." Our modern schemes of astronomy, geology, biology, are all framed on the assumption of past time immense in length. In fact, one reason why the latter sciences grew so slowly till almost our own day, was their being shackled by the bonds of a short chronology, allowing no room for the long successive periods through which it is now clear that the earth with its plants and animals passed into their present state. Even the Science of Man, though concerned with the later forms of being, belonging to times which geologists treat as almost modern, has nevertheless to deal with periods of time extending far back beyond the range of history and chronology.

Looking back 4,000 to 5,000 years, what is the appearance of mankind as disclosed to us by the Egyptian monuments and inscriptions? Several of the best-marked races of man were already in existence, including the brown Egyptian himself, the dark-white Semitic man of Assyria or Palestine, the Central African of two varieties, which travellers still find as distinct as ever, namely, the black or Negro proper, and the copper-coloured negroid, like the Bongo or Nyam-nyam of our own time. Indeed, the evidence accessible as to ancient races of man goes to prove that the causes which brought about their differences in types of skull, hair, skin, and constitution, did their chief work in times before history began. Since then the races which had become adapted to their geographical regions may have, on the whole, undergone little change while remaining there, but some alterations are traced as due to migration into new climates. Even these are difficult to follow, masked as they are by the more striking changes produced by intermarriage of races. Now the view that the races of man are to be accounted for as varied descendants of one original stock is zoologically probable from the close resemblance of all men in body and mind, and the freedom with which races intercross. If it was so, then the fact of the different races already existing early in the historical period compels the naturalist to look to a prehistoric period for their development to have taken place in. And considering how strongly differenced are the Negro and the Syrian, and how slowly such changes of complexion and feature take place within historical experience, this prehistoric period was probably of vast length. The evidence from the languages of the world points in the same direction. In times of ancient history we already meet with families of languages, such as the Aryan and the Semitic, and as later history goes on many other families of language come into view, such as the Bantu or Kafir of Africa, the Dravidian of South India, the Malayo-Polynesian, the Algonquin of North America, and other families. But what we do not find is the parent language of any of these families, the original language which all the other members are dialects of, so that this parent tongue should stand towards the rest in the relation which Latin holds to its descendants, Italian and French. It is, however, possible to work back by the method of philological comparison, so as to sketch the outlines of that early Aryan tongue which must have existed to produce Sanskrit and Persian, Greek and Latin, German, Russian, and Welsh, or the outlines of that early Semitic tongue which must have existed to produce Assyrian, Phœnician, Hebrew, and Arabic. Though such theoretical reconstructions of parent language from their descendants may only show a vague and shadowy likeness to the

reality, they give some idea of it. And what concerns us here is that theoretical early Aryan and Semitic, or other such reconstructed languages, do not bring our minds appreciably nearer to really primitive forms of speech. However far we get back, the signs of development from still earlier stages are there. The roots have mostly settled into forms which no longer show the reasons why they were originally chosen, while the inflexions only in part preserve traces of their original senses, and the whole structure is such as only a long-lost past can account for. To illustrate this important point, let us remember the system of grammatical gender in Greek or German, how irrationally a classification by sex is applied to sexless objects and thoughts, while even the use of a neuter gender fails to set the confusion straight, and sometimes even twists it with a new perversity of its own. Many a German and Frenchman wishes he could follow the example of our English forefathers who, long ago, threw overboard the whole worthless cargo of grammatical gender. But looking at gender in the ancient grammars, it must be remembered that human custom is hardly ever wilfully absurd, its unreasonableness usually arising from loss or confusion of old sense. Thus it can hardly be doubted that the misused grammatical gender in Hebrew or Greek is the remains of an older and reasonable phenomenon of language; but if so, this must have belonged to a period earlier than we can assign to the theoretical parent language of either. Lastly, the development of civilisation requires a long period of prehistoric time. Experience and history show that civilisation grew up gradually, while every age preserves recognisable traces of the ages which went before. The woodman's axe of to-day still retains much of the form of its ancestor—the stone celt in its wooden handle; the mathematician's tables keep up in their decimal rotation a record of the early ages when man's ten fingers first taught him to count; the very letters with which I wrote these lines may be followed back to the figure of birds and beasts and other objects drawn by the ancient Egyptians, at first as mere picture-writing to denote the things represented. Yet, when we learn from the monuments what ancient Egyptian life was like towards 5,000 years ago, it appears that civilisation had already come on so far that there was an elaborate system of government, an educated literary priesthood, a nation skilled in agriculture, architecture, and metal work. These ancient Egyptians, far from being near the beginning of civilisation, had, as the late Baron Bunsen held, already reached its halfway house. This eminent Egyptologist's moderate estimate of man's age on the earth at about 20,000 years has the merit of having been made on historical grounds alone, independently of geological evidence, for the proofs of the existence of man in the quaternary or mammoth period had not yet gained acceptance.

My purpose in briefly stating here the evidence of man's antiquity derived from race, language, and culture, is to insist that these arguments stand on their own ground. It is true that the geological argument from the implements in the drift-gravels and bone-caves, by leading to a general belief that man is extremely ancient on the earth, has now made it easier to anthropologists to maintain a rationally satisfactory theory of the race-types and mental development of mankind. But we should by no means give up this vantage-ground, though the ladder we climbed by should break down. Even if it could be proved that the flint implements of Abbeville or Torquay were really not so ancient as the pyramids of Egypt, this would not prevent us from still assuming, for other and sufficient reasons, a period of human life on earth extending many thousand years farther back.

It is an advantage of this state of the evidence that it to some extent gets rid of the "sensational" element in the problem of fossil man, which it leaves as merely an interesting inquiry into the earliest known relics of savage tribes. Geological criticism has not yet absolutely settled either way the claims of the Abbé Bourgeois' flints from Thénay to be of miocene date, or of Mr. Skertchly's from Brandon to be glacial. The accepted point is that the men who made the ordinary flint implements of the drift lived in the quaternary period characterised by the presence of the mammoth in our part of Europe. More than one geologist, however, has lately maintained that this quaternary period was not of extreme antiquity. The problem is at what distance from the present time the drift-gravels on the valley slopes can have been deposited by water action up to one hundred feet or so above the present flood-levels. It does not seem the prevailing view among geologists that rivers on the same small scale as those at present occupying mere ditches in the wide valley-floors could have left these deposits on the hill sides at a time when they had not yet scooped out the valleys to within fifty or a hundred feet of their present depth. Indeed, such means are insufficient out of all proportion to the results, as a mere look down from the hill-tops into such valleys is enough to show. Geologists connect the deposit of the high drift-gravels with the subsidence and elevation of the land, and the powerful action of ice and water at the close of the Glacial age; and the term "Pluvial period" is often used to characterise this time of heavy rainfall and huge rivers. It was then that the rude stone implements of palæolithic man were imbedded in the drift-gravels with the remains of the mammoth and fossil rhinoceros, and we have to ask what events have taken place in these regions since? The earth's surface has been altered to bring the land and water to their present levels, the huge animals became extinct, the country was inhabited by the tribes whose relics belong to the neolithic or polished-stone age, and afterwards the metal-using Keltic nations possessed the land, their arrival being fixed as previous to 400 B.C., the king of the Gauls then being called by the Romans by the name *Brennus*, which is simply the Keltic word for "king"—in modern Welsh *brenin*. To take in this succession of events geologists and archæologists generally hold that a long period is required. Yet there are some few who find room for them all in a comparatively short period. I will mention Principal Dawson, of Montreal, well known as a geologist in this Association, and who has shown his conviction of the soundness of his views by addressing them to the general public in a little volume entitled "The Story of the Earth and Man." Having examined the gravels of St. Acheul, on the Somme, where M. Boucher de Perthes found his celebrated drift implements, it appeared to Dr. Dawson that, taking into account the probabilities of a different level of the land, a wooded condition of the country and greater rainfall, and a glacial filling up of the Somme valley with clay and stones subsequently cut out by running water, the gravels could scarcely be older than the Abbeville peat, and the age of this peat he estimates as perhaps less than four thousand years. Within this period Dr. Dawson includes a comparatively rapid subsidence of the land, with a partial re-elevation, which left large areas of the lower grounds beneath the sea. This he describes as the geological deluge which separates the post-glacial period from the modern, and the earlier from the later prehistoric period of the archæologists.

My reason for going here into these computations of Dr. Dawson's is that the date about 2,200 B.C., to which he thus assigns these great geological convulsions, is actually within historic times. In Egypt successive dynasties had been reigning for ages, and the pyramids had long been built; while in Babylonia the old Chaldæan kings had been raising the temples whose ruins still remain. That is to say, we are asked to receive, as matter of geology, that stupendous geological changes were going on not far from the Mediterranean, including a final plunge of I know not how much of the earth's surface beneath the waters, and yet national life on the banks of the Nile and the Euphrates went on unbroken and apparently undisturbed through it all. To us in this section it is instructive to see how the free use of paroxysms and cataclysms makes it possible to shorten up geological time. Accustomed as we are to geology demanding periods of time which often seem to history exorbitant, the tables are now turned, and we are presented with the unusual spectacle of chronology protesting against geology for encroaching on the historical period.

In connection with the question of quaternary man, it is worth while to notice that the use of the terms "primæval" or "primitive" man, with reference to the savages of the mammoth period, seems sometimes to lead to unsound inferences. There appears no particular reason to think that the relics from the drift-beds or bone-caves represent man as he first appeared on the earth. The contents of the caves especially bear witness to a state of savage art, in some respects fairly high, and which may possibly have somewhat fallen off from an ancestral state in a more favourable climate. Indeed, the savage condition generally, though rude and more or less representing early stages of culture, never looks absolutely primitive, just as no savage language ever has the appearance of being a primitive language. What the appearance and state of our really primæval ancestors may have been seems too speculative a question, until there shall be more signs of agreement between the anthropologists, who work back by comparison of actual races of man toward a hypothetical common stock, and the zoologists, who approach the problem through the species adjoining the human. There is, however, a point relating to the problem to which attention is

due. Naturalists not unreasonably claim to find the geographical centre of man in the tropical regions of the Old World inhabited by his nearest zoological allies, the anthropomorphous apes, and there is at any rate force enough in such a view to make careful quest of human remains worth while in those districts, from Africa across to the Eastern Archipelago. Under the care of Mr. John Evans a fund has been raised for excavations in the caves of Borneo by Mr. Everett, and though the search has as yet had no striking result, money is well spent in carrying on such investigations in likely equatorial forest regions. It would be a pity that for want of enterprise a chance, however slight, should be missed of settling a question so vital to anthropology.

While the problem of primitive man thus remains obscure, a somewhat more distinct opinion may be formed on the problem of primitive civilised man. When it is asked what races of mankind first attained to civilisation, it may be answered that the earliest nations known to have had the art of writing, the great mark of civilisation as distinguished from barbarism, were the Egyptians and Babylonians, who in the remotest ages of history appear as nations advanced to the civilised stage in arts and social organisation. The question is, under what races to class them? What the ancient Egyptians were like is well known from the monuments, which show how closely much of the present fellah population, as little changed in features as in climate and life, represent their ancestors of the times of the Pharaohs. Their reddish-brown skin, and features tending toward the negroid, have led Hartmann, the latest anthropologist who has carefully studied them, to adopt the classification of them as belonging to the African rather than the Asiatic peoples, and especially to insist on their connection with the Berber type, a view which seems to have been held by Blumenbach. The contrast of the brown Egyptians with the dark-white Syro-Arabians on their frontiers is strongly marked, and the portraits on the monuments show how distinctly the Egyptian knew himself to be of different race from the Semite. Yet there was mixture between the two races, and what is most remarkable, there is a deep-seated Semitic element in the Egyptian language, only to be accounted for by some extremely ancient and intimate connection. On the whole, the Egyptians may be a mixed race, mainly of African origin, perhaps from the southern Somaliland, whence the Egyptian tradition was that the gods came, while their African type may have since been modified by Asiatic admixture. Next, as to the early relations of Babylonia and Media, a different problem presents itself. The languages of these nations, the so-called Akkadian and the early Medic, were certainly not of the same family with either the Assyrian or the Persian which afterwards prevailed in their districts. Their connection with the Tatar or Turanian family of languages, asserted twenty years ago by Oppert, has since been further maintained by Lenormant and Sayce, and seems, if not conclusively settled, at any rate to have much evidence for it, not depending merely on similarity of words, such as the term for "god," Akkadian *dingira*, being like the Tatar *tengri*, but also on the similarity of pronouns and grammatical structure by postpositions. Now language, though not a conclusive argument as to race, always proves more or less as to connection. The comparison of the Akkadian language to that of the Tatar family is at any rate *primâ facie* evidence that the nations who founded the ancient civilisation of Babylonia, who invented the cuneiform writing, and who carried on the astronomical observations which made the name of Chaldæan famous for all time, may have been not dark-white peoples like the Assyrians who came after them, but perhaps belonged to the yellow race of Central Asia, of whom the Chinese are the branch now most distinguished in civilisation. M. Lenormant has tried to identify among the Assyrian bas-reliefs certain figures of men whose round skulls, high cheek-bones, and low-bridged noses present a Mongoloid type contrasting with that of the Assyrians. We cannot, I think, take this as proved, but at any rate in these figures the features are not those of the aquiline Semitic type. The bronze statuette of the Chaldæan king called Gudea, which I have examined with Mr. Pinches at the British Museum, is also, with its straight nose and long thin beard, as un-Assyrian as may be. The anthropological point towards which all this tends is one of great interest. We of the white race are so used to the position of leaders in civilisation, that it does not come easy to us to think we may not have been its original founders. Yet the white race, whether the dark-whites, such as Phœnicians or Hebrews, Greeks or Romans, or the fair-whites, such as Scandinavians and Teutons, appear in history as followers and disciples of the Egyptians and Babylonians who taught the world writing, mathemathics, philosophy. These Egyptians and Babylonians, so far as present evidence reaches, seem rather to have belonged to the races of brown and yellow skin than to the white race.

It may be objected that this reasoning is in several places imperfect, but it is the use of a departmental address not only to lay down proved doctrines, but to state problems tentatively as they lie open to further inquiry. This will justify my calling attention to a line of argument which, uncertain as it at present is, may perhaps lead to an interesting result. So ancient was civilisation among both Egyptians and Chaldæans, that the contest as to their priority in such matters as magical science was going on hotly in the classic ages of Greece and Rome. Looking at the literature and science, the arts and politics, of Memphis and of Ur of the Chaldees, both raised to such height of culture near 5,000 years ago, we ask, were these civilisations not connected, did not one borrow from the other? There is at present a clue which, though it may lead to nothing, is still worth trial. The hint of it lies in a remark by Dr. Birch as to one of the earliest of Egyptian monuments, the pyramid of Kochome, near Sakkara, actually dating from the first dynasty, no doubt beyond 3000 B.C., and which is built in steps like the seven-storeyed Babylonian temples. Two other Egyptian pyramids, those of Abu-sīr, are also built in steps. Now whether there is any connection between the building of these pyramids and the Babylonian towers, does not depend on their being built in stages, but in the number of these stages being seven. As to the Babylonian towers, there is no doubt, for though Birs-Nimrud is now a ruinous heap, the classical descriptions of such temples, and the cuneiform inscriptions, put it beyond question that they had seven stages, dedicated to the seven planets. As to the Egyptian pyramids, the archæologists Segato and Masi positively state of one step-pyramid of Abur-sir, that it had seven decreasing stages, while, on the other hand, Vyse's reconstruction of the step-pyramid of Sakkara shows there only six. Considering the ruinous state of all three step-pyramids, it will require careful measurement to settle whether they originally had seven stages or not. If they had, the correspondence cannot be set down to accident, but must be taken to prove a connection between Chaldæa and Egypt as to the worship of the seven planets, which will be among the most ancient links connecting the civilisations of the world. I hope by thus calling attention to the question, to induce some competent architect visiting Egypt to place the matter beyond doubt, one way or the other.

While speaking of the high antiquity of civilisation in Egypt, the fact calls for remark, that the use of iron as well as bronze in that country seems to go back as far as historical record reaches. Brugsch writes in his "Egypt under the Pharaohs," that Egypt throws scorn on the archæologists' assumed successive periods of stone, bronze, and iron. The eminent historian neglects, however, to mention facts which give a different complexion to the early Egyptian use of metals, namely, that chipped flints, apparently belonging to a prehistoric Stone Age, are picked up plentifully in Egypt, while the sharp stones or stone knives used by the embalmers seem also to indicate an earlier time when these were the cutting instruments in ordinary use. Thus there are signs that the Metal Age in Egypt, as elsewhere in the world, was preceded by a Stone Age, and if so, the high antiquity of the use of metal only throws back to a still higher antiquity the use of stone. The ancient iron-working in Egypt is, however, the chief of a group of facts which are now affecting the opinions of anthropologists on the question whether the Bronze Age everywhere preceded the Iron Age. In regions where, as in Africa, iron ore occurs in such a state that it can after mere heating in the fire be forged into implements, the invention of iron-working would be more readily made than that of the composite metal bronze, which perhaps indicates a previous use of copper, afterwards improved on by an alloy of tin. Prof. Rolleston, in a recent address on the Iron, Bronze, and Stone Ages, insists with reason that soft iron may have been first in the hands of many tribes, and may have been superseded by bronze as a preferable material for tools and weapons. We moderns, used to fine and cheap steel, hardly do justice to the excellence of bronze, or gun-metal as we should now call it, in comparison with any material but steel. I well remember my own surprise at seeing in the Naples Museum that the surgeons of Herculaneum and Pompeii used instruments of bronze. It is when hard steel comes in, that weapons both of bronze and wrought iron have to yield, as when the long soft iron broad-

swords of the Gauls bent at the first blow against the pikes of Flaminius' soldiers. On the whole, Prof. Virchow's remarks in the *Transactions* of the Berlin Anthropological Society for 1876, on the question whether it may be desirable to recognise instead of three only two ages, a Stone Age and a Metal Age, seem to put the matter on a fair footing. Iron may have been known as early as bronze or even earlier, but nevertheless there have been periods in the life of nations when bronze, not iron, has been the metal in use. Thus there is nothing to interfere with the facts resting on archæological evidence, that in such districts as Scandinavia or Switzerland a Stone Age was at some ancient time followed by a Bronze Age, and this again by an Iron Age. We may notice that the latter change is what has happened in America within a few centuries, where the Mexicans and Peruvians, found by the Spaniards living in the Bronze Age, were moved on into the Iron Age. But the question is whether we are to accept as a general principle in history the doctrine expounded in the poem of Lucretius, that men first used boughs and stones, that then the use of bronze became known, and lastly iron was discovered. As the evidence stands now, the priority of the Stone Age to the Metal Age is more firmly established than ever, but the origin of both bronze and iron is lost in antiquity, and we have no certain proof which came first.

Passing to another topic of our science, it is satisfactory to see with what activity the comparative study of laws and customs, to which Sir Henry Maine gave a new starting-point in England, is now pursued. The remarkable inquiry into the very foundations of society in the structure of the family, set afoot by Bachofen in his "Mütterrecht," and M'Lennan in his "Primitive Marriage," is now bringing in every year new material. Mr. L. H. Morgan, who, as an adopted Iroquois, became long ago familiar with the marriage laws and ideas of kinship of uncultured races, so unlike those of the civilised world, has lately made, in his "Ancient Society," a bold attempt to solve the whole difficult problem of the development of social life. I will not attempt here any criticism of the views of these and other writers on a problem where the last word has certainly not been said. My object in touching the subject is to mention the curious evidence that can still be given by rude races as to their former social ties, in traditions which will be forgotten in another generation of civilised life, but may still be traced by missionaries and others who know what to seek for. Thus, such inquiry in Polynesia discloses remarkable traces of a prevalent marriage-tie which was at once polygamous and polyandrous, as where a family of brothers were married jointly to a family of sisters; and I have just noticed in a recent volume on "Native Tribes of South Australia," a mention of a similar state of things occurring there. As to the general study of customs, the work done for years past by such anthropologists as Prof. Bastian, of Berlin, is producing substantial progress. Among recent works I will mention Dr. Karl Andree's "Ethnologische Parallelen" and Mr. J. A. Farrer's "Primitive Manners." In the comparison of customs and inventions, however, the main difficulty still remains to be overcome, how to decide certainly whether they have sprung up independently alike in different lands through likeness in the human mind, or whether they have travelled from a common source. To show how difficult this often is, I may mention the latest case I have happened to meet with. The Orang Dongo, a mountain people in the Malay region, have a custom of inheritance that when a man dies the relatives each take a share of the property, and the deceased inherits one share for himself, which is burnt or buried for his ghost's use, or eaten at the funeral feast. This may strike many of my hearers as quaint enough and unlikely to recur elsewhere; but Mr. Charles Elton, who has special knowledge of our ancient legal customs, has pointed out to me that it was actually old Kentish law, thus laid down in Law-French:—"Ensement seient les chateus de gauylekendeys parties en treis apres le exequies e les dettes rendues si il y est issne mulier en vye, issi que la mort eyt la une partie, e les fitz e les filles muliers lautre partie e la femme la tierce partie."—"In like sort let the chattels of gavelkind persons be divided into three after the funeral and payment of debts, if there be lawful issue living, so that the deceased have one part, and the lawful sons and daughters the other part, and the wife the third part." The Church had indeed taken possession, for pious uses, of the dead man's share of his own property; but there is good Scandinavian evidence that the original custom before Christian times was for it to be put in his burial-mound. Thus the right of the rude Malay tribe corresponds with that of ancient Europe, and the question which the evidence does not yet enable us to answer, is whether the custom was twice invented, or whether it spread east and west from a common source, perhaps in the Aryan district of Asia.

It remains for me to notice the present state of Comparative Mythology, a most interesting, but also most provoking part of Anthropology. More than twenty years ago a famous essay, by Prof. Max Müller, made widely known in England how far the myths in the classical dictionary and the story-books of our own lands might find their explanation in poetic nature-metaphors of sun and sky, cloud and storm, such as are preserved in the ancient Aryan hymns of the Veda. Of course it had been always known that the old gods and heroes were in some part personifications of nature—that Helios and Okeanos, though they walked and talked and begat sons and daughters were only the Sun and Sea in poetic guise. But the identifications of the new school went farther. The myth of Endymion became the simple nature-story of the setting Sun meeting Selene the Moon; and I well remember how, at the Royal Institution, the aged scholar, Bishop Thirlwall, grasped the stick he leant on, as if to make sure of the ground under his feet, when he heard it propounded that Erinys, the dread avenger of murder, was a personification of the Dawn discovering the deeds of darkness. Though the study of mythology has grown apace in these later years, and many of its explanations will stand the test of future criticism, I am bound to say that mythologists, always an erratic race, have of late been making wilder work than ever with both myth and real history, finding mythic suns and skies in the kings and heroes of old tradition, with dawns for love-tales, storms for wars, and sunsets for deaths, often with as much real cogency as if some mythologist a thousand years hence should explain the tragic story of Mary Queen of Scots as a nature-myth of a beauteous Dawn rising in splendour, prisoned in a dark cloud-island, and done to death in blood-red sunset. Learned treatises have of late, by such rash guessings, shaken public confidence in the more sober reasonings on which comparative mythology is founded, so that it is well to insist that there are cases where the derivation of myths from poetic metaphors is really proved beyond doubt. Such an instance is the Hindu legend of King Bali, whose austerities have alarmed the gods themselves, when Vâmana, a Brahmanic Tom Thumb, begs of him as much land as he can measure in three steps; but when the boon is granted, the tiny dwarf expands gigantic into Vishnu himself, and striding with one step across the earth, with another across the air, and a third across the sky, drives the king down into the infernal regions, where he still reigns. There are various versions of the story, of which one may be read in Southey; but in the ancient Vedic hymns its origin may be found when it was not as yet a story at all, only a poetic metaphor of Vishnu, the Sun, whose often-mentioned act is his crossing the airy regions in his three strides. "Vishnu traversed (the earth), thrice he put down his foot; it was crushed under his dusty step. Three steps hence made Vishnu, unharmed preserver, upholding sacred things." Both in the savage and civilised world there are many myths which may be plainly traced to such poetic fancies before they have yet stiffened into circumstantial tales; and it is in following out these, rather than in recklessly guessing myth-origins for every tradition, that the sound work of the mythologist lies. The scholar must not treat such nature-poetry like prose, spoiling its light texture with too heavy a grasp. In the volume published by our new Folk-Lore Society, which has begun its work so well, Mr. Lang gives an instance of the sportive nature-metaphor which still lingers among popular story-tellers. It is Breton, and belongs to that wide-spread tale of which one version is naturalised in England as "Dick Whittington and his Cat." The story runs thus:—The elder brother has the cat, while the next brother, who has a cock left him, fortunately finds his way to a land where (there being no cocks) the king has every night to send chariots and horses to bring the dawn; so that here the fortunate owner of Chanticleer has brought him to a good market. Thus we see that the Breton peasant of our day has not even yet lost the mythic sense with which his remote Aryan ancestors could behold the chariots and horses of the dawn. But myth, though largely based on such half-playful metaphor, runs through all the intermediate stages which separate poetic fancy from crude philosophy embodied in stories seriously devised as explanations of real facts. No doubt many legends of the ancient world, though not really history, are myths which have arisen by reasoning on actual events, as definite as that which, some four years ago, was terrifying the peasant mind in North

Germany, and especially in Posen. The report had spread far and wide that all Catholic children with black hair and blue eyes were to be sent out of the country, some said to Russia, while others declared that it was the King of Prussia who had been playing cards with the Sultan of Turkey, and had staked and lost 40,000 fair-haired blue-eyed children; and there were Moors travelling about in covered carts to collect them; and the schoolmasters were helping, for they were to have five dollars for every child they handed over. For a time the popular excitement was quite serious; the parents kept the children away from school and hid them, and when they appeared in the streets of the market-town the little ones clung to them with terrified looks. Dr. Schwartze, the well-known mythologist, took the pains to trace the rumour to its sources. One thing was quite plain, that its prime cause was that grave and learned body, the Anthropological Society of Berlin, who, without a thought of the commotion they were stirring up, had, in order to class the population as to race, induced the authorities to have a census made throughout the local schools, to ascertain the colour of the children's skin, hair, and eyes. Had it been only the boys, to the Government inspection of whom for military conscription the German peasants are only too well accustomed, nothing would have been thought of it; but why should the officials want to know about the little girls' hair and eyes? The whole group of stories which suddenly sprang up were myths created to answer this question; and even the details which became embodied with them could all be traced to their sources, such as the memories of German princes selling regiments of their people to pay their debts, the late political negotiations between Germany and Russia, &c. The fact that a caravan of Moors had been travelling about as a show accounted for the covered carts with which they were to fetch the children; while the schoolmasters were naturally implicated, as having drawn up the census. One schoolmaster, who evidently knew his people, assured the terrified parents that it was only the children with blue hair and green eyes that were wanted—an explanation which sent them home quite comforted. After all, there is no reason why we should not come in time to a thorough understanding of mythology. The human mind is much what it used to be, and the principles of myth-making may still be learnt from the peasants of Europe.

When, within the memory of some here present, the Science of Man was just coming into notice, it seemed as though the study of races, customs, traditions, were a limited though interesting task, which might, after a few years, come so near the end of its materials as no longer to have much new to offer. Its real course has been far otherwise. Twenty years ago it was no difficult task to follow it step by step; but now even the yearly list of new anthropological literature is enough to form a pamphlet, and each capital of Europe has its anthropological society in full work. So far from any look of finality in anthropological investigations, each new line of argument but opens the way to others behind, while these lines tend as plainly as in the sciences of stricter weight and measure, toward the meeting-ground of all sciences in the unity of nature

SECTION G

MECHANICAL SCIENCE

OPENING ADDRESS BY J. ROBINSON, PRES. INST. MECH. ENG., PRESIDENT OF THE SECTION

On the Development of the Use of Steel during the Last Forty Years, considered in its Mechanical and Economic Aspects

MUCH has been written by poets and others of a succession of the Ages of the human race in comparing their degradation with the various kinds of metal, considered metaphorically—thus we have the golden age, the silver age, the age of brass, and the age of iron.

Our own time may very appropriately and literally be described as a branch of the latter age, and be named the age of steel.

In the metropolis of the steel manufacture it would seem fitting that the Mechanical Section of this great scientific association should direct its attention to this wonderful metal, the uses of which are daily becoming more numerous and important.

But it may be said, on the other hand, that as the use of this material is perpetually growing more common, so are discussions as to its manufacture, composition, and characteristics, becoming almost wearisome from their frequency.

Notwithstanding an appearance of truth in this objection to our occupying more time in referring to the subject, I would venture to entertain the hope that a treatment of the question in its mechanical and economic aspects may prove not uninteresting to this meeting.

At the time when railway extension was becoming general, about forty years ago, the use of steel in this country was confined mainly to tools for mechanical purposes, including files and other articles, springs for vehicles, weapons of various sorts, and implements for agricultural and domestic uses; and it is proposed to measure the scientific and mechanical energy brought to bear upon the manufacture and improvement of this metal by the increase in the number of purposes to which it is applied, and the diminished price at which it can be obtained, as compared with the price at the time of its introduction for constructive works. There are, however, several important exceptions to this method of appreciation to which reference will hereafter be made.

We will take, then, the simplest form in the preceding list, viz., *tool steel*, the price of which for ordinary purposes varied from 50*s*. to 56*s*. per cwt. at the period I have named; and we shall find that the development of the manufacture of steel in general has but little affected this particular material, which is still produced in much the same fashion, *i.e.*, by the use of carefully selected Swedish iron, carburised by exposure in ovens to the heat of burning charcoal, and then recast from crucibles and hammered down to the required size. The result of a somewhat stationary condition of manufacture has been the maintenance of prices, at the same, or about the same, level up to the present time.

A superior quality of tool steel has been produced by the adoption of a process invented by Mr. R. Mushet, in which titanium is introduced in the manufacture, and which dates back to the year 1838-39. This steel is of great endurance when applied to the working of steel and iron of considerable hardness, and its higher price of 140*s*. per cwt. is quite justified by the excellent results obtained from its use, and other steels of similar fine quality are produced by several manufacturers, who make specialties of them.

Some twenty-seven or twenty-eight years ago, Krupp, of Essen, gave an enormous impulse to the application of steel, by his method of producing much larger masses of crucible steel than had previously been possible. He at that time accomplished the casting of an ingot of "crucible" steel of 50 cwt., a weight then considered incredible, and this was followed up by the production of weldless cast steel tyres in 1852, which led to the very rapid development in the use of his steel for railway tyres, cranked axles for locomotive and other engines, straight axles and shafts, and parts of machines in general.

It is most interesting to consider the prices of such of these objects as have up to this time maintained similar forms, with the object of ascertaining by the selling price, the progress in the scientific and mechanical appliances used for the production of the materials just referred to.

At the time of their coming into use, about twenty-five years ago, the price of cast steel tyres was 120*s*. per cwt.; it is now from 18*s*. to 25*s*. per cwt. The price of forged steel cranked axles was, when first introduced, 15*l*. per cwt.; it is now from 65*s*. to 70*s*. per cwt.

The price of straight axles and shafts was from 40*s*. to 50*s*. per cwt.; it is now from 19*s*. 6*d*. to 23*s*. per cwt.

Now to what do we owe this enormous reduction of price and consequent more frequent and more economic application? The answer must be that, following the initiation of Krupp, our English engineers and men of science set themselves to work to discover and apply new processes for the production and manufacture of this most wonderful metal; and I venture to say that in the whole history of metallurgy, from the time of Tubal Cain downwards, there has been no such progress in invention and manufacture as has been realised by the aid of such men as Mushet, Krupp, Bessemer, Siemens, Whitworth, Martin, Vickers, Betl, Bauschinger, Styffe, and many others within the period comprised in this retrospect; and our national predilections will perhaps lead us to the opinion that our own country may fairly appropriate a large share of merit for the results achieved.

Another of the uses of steel to which attention may be given is that of the production of cannon of large size.

Efforts had been made by some of our enterprising workers in metal to produce large guns of solid wrought iron; but the

processes of heating and hammering were attended with so much difficulty that the attempt was given up. Here again Krupp stepped in, and succeeded, thirty-two years ago, in manufacturing cannon of cast steel, which unhappily have become ordinary commodities with those nationalities who could afford such expensive weapons. Since that time Krupp has produced about 2,000 guns, the heaviest being, when finished, 72 tons (16 inch).

Sir William Armstrong and Sir Joseph Whitworth soon came into the field with guns of their own invention. The former, by adopting the system of iron coils applied externally to a central cylinder; and the latter, by shrinking cylindrical hoops on to a central cylinder made of cast steel.

In the adaptation of the steel manufacture of the cast or crucible steel period to the production of every object demanded by the march of engineering and mechanical science, I need not mention the names of individuals and firms in this town who have shown themselves equal to the task; but I will venture to say that their success has been such as to raise the town of Sheffield to the very pinnacle of fame as producing steel of any, even the highest quality demanded in the markets of the world.

I must now turn to a name honoured everywhere for the benefits and renown he has brought to his country by his inventions and appliances, developed during the last twenty-four or twenty-five years, in the manufacture of a steel which can be cheaply produced and readily adapted to the requirements of the purchaser. I am sure the audience will in their minds anticipate the record of the name of Bessemer—a name which will be handed down to posterity in connection with the manufacture of steel as long as that manufacture exists.

Another name which will most deservedly figure in the history of the development of the steel manufacture is one, like that of Bessemer, which has been known not only in that development, but in connection with many other discoveries in physical science—I mean that of Siemens, who, like his compeer, has not only invented processes, but has personally carried them out into practical application. An expression let fall by the latter as President of the Iron and Steel Institute at its meeting last year in Paris, exhibits very strikingly the absence of any other feeling on the part of these two great men save that of the most friendly rivalry.

Speaking of a comparison between the results of steel manufactured by the Bessemer blowing process and the Siemens-Martin open-hearth process, Dr. Siemens said, "He did not see how the result could be the same. It might be better in the Bessemer process than in the open hearth for aught he knew, but it could not be the same;" and it seems to augur well for the advancement of science in our day that so little of a contrary spirit is exhibited in the discussions which ensue from time to time upon any improved process either chemical or mechanical, having for its object the production of a better material at a lower first cost. The name of Robert Mushet may very properly be introduced here as one of our early inventors of the improved processes for the manufacture of steel, and it is gratifying to find that other countries besides England have learnt to appreciate the results obtained by him during so many years of scientific and experimental research.

It is needless that I should do more in an assembly like that before me than refer, in the simplest terms, to the differences in the processes of manufacture connected with these names.

In that of Bessemer, pig-iron of a selected quality is charged into what is technically called a "converter," a large cast-iron vessel into which air can be blown at considerable velocity by suitable blowing machinery. This goes on until the iron is thoroughly oxidised, and the impurities contained in the metal are driven off. When this happens the blowing ceases, and a certain proportion of Spiegeleisen or of ferro-manganese is added to the charge so as to give the required amount of carbon. Blowing recommences, this time only to effect complete mixture of the materials, and then the casting of the ingots takes place of a quality corresponding to the metal selected for the mixtures. A mild steel—or, as it has been called, a pure iron—is the resultant, and it is capable of being worked, welded, and hammered very much as in the case of the purest wrought irons; but it possesses generally a much higher tensile resistance and a greater ductility.

In the Siemens-Martin, or open-hearth process, a similar charge of pig-iron of the desired quality—probably hæmatite pig—is put into the bed of a reverberatory furnace of the regenerative system, and the necessary oxidation is produced by adding to the molten mass iron ores, or oxides of iron in proportions ascertained by experience, after which re-carbonisation is obtained by the addition of ferro-manganese or Spiegeleisen as in the Bessemer process.

These processes have been the great factors in that reduction in the cost price, and therefore in the extension of the use of such objects as steel tyres, axles, shafts, rails, &c., to which I have already referred, and which is so striking an instance of the results which our men of science can accomplish by their physical and experimental researches into the means of supplying the wants of our work-a-day world.

I will now draw attention to another product of the steel manufacture which is of immense importance, and which could not have been obtained for ordinary purposes but for the facilities of manufacture arising out of the inventions I have just alluded to —I mean that of steel castings, *i.e.* castings obtained from the crucible, precisely in the form in which they are to be used in the construction of machinery, just as is the case in ordinary cast iron run from the cupola furnace. This production of castings for engineering purposes is gaining an enormous and rapid development; and when it is considered that in this metal we obtain castings of a strength at least three to four times that of the strongest iron castings, the importance of this experimental discovery can scarcely be over-rated.

Nor must I pass over the application of these processes to the production of boiler plates, bridge girder plates, and ship plates, in which, as a result of the greater tensile resistance of such plates (reaching for ordinary uses a figure of about twenty-eight to thirty-four tons to the square inch), the engineer is not only enabled to lighten his structure, but to expect from it greater durability—an expectation not diminished by its greater capability of resisting corrosion, especially where care is taken to exclude manganese from the mixture of the metals employed.

For specific purposes, and where price is not so much an element of consideration as great tensile or percussive resistance, a more costly mode of manufacture has been adopted by Sir Joseph Whitworth, whose attention was probably drawn to the necessity for obtaining such a metal, during the construction of cannon and torpedoes, but which has now been extended to objects of a very varied character. The method of manufacture, which has been in use upwards of ten years, is by casting ingots under very heavy hydraulic pressures, from very carefully selected materials, the result being the production of a metal of enormous tensile resistance, reaching, in some instances, the high figure of 100 tons per square inch, while at the same time the bubbles and air vesicles, which sometimes appear in metal produced in the ordinary methods, are entirely or almost entirely got rid of, and the consequent striations and imperfections of internal structure and external surface disappear.

It is hoped that ere long we shall be able to procure in this way cylindrical boiler plates rolled solid from the ingot, much after the fashion in which weldless steel tyres are now obtained, and that the weakening of these plates by the existing necessity for forming horizontal riveted joints may thus be avoided.

It is desirable before closing this, I fear, already somewhat long address, to call attention to the most recent development of the steel manufacture as exhibited in the processes of Messrs. Snellus, Gilchrist, and Thomas, by which iron containing a considerable proportion of, say, 1·44 per cent. of phosphorus, may, in the course of its manufacture into either Bessemer or Seimens-Martin steel, have this deleterious matter entirely removed, or reduced to an inconsiderable proportion.

The method of carrying out this operation was exceedingly well described at the recent meeting of the Iron and Steel Institute in London, and it was shown that where such irons were melted in vessels lined with a slag having twenty per cent. of silica and thirty per cent. of lime and magnesia, the phosphorus was gradually and effectually absorbed by this lining, and a steel of good quality, comparatively free from phosphorus and silica, was produced.

The result to the community will naturally be that, as henceforth a much more extended area of our iron fields both at home and abroad will become available for the production of steel, the use of that metal will be still further extended and its price reduced mainly by means of the methodical researches of our scientific metallurgists, and entirely independently of those accidental combinations which have in less scientific days led to the adoption of new and improved methods in the production of metals required by the progress of mechanical and economic science.

ON RADIANT MATTER[1]

TO throw light on the title of this lecture I must go back more than sixty years—to 1816. Faraday, then a mere student and ardent experimentalist, was twenty-four years old, and at this early period of his career he delivered a series of lectures on the general properties of matter, and one of them bore the remarkable title, "On Radiant Matter." The great philosopher's notes of this lecture are to be found in Dr. Bence Jones's "Life and Letters of Faraday," and I will here quote a passage in which he first employs the expression *Radiant Matter*:—

"If we conceive a change as far beyond vaporisation as that is above fluidity, and then take into account also the proportional increased extent of alteration as the changes rise, we shall perhaps, if we can form any conception at all, not fall far short of radiant matter; and as in the last conversion many qualities were lost, so here also many more would disappear."

Faraday was evidently engrossed with this far-reaching speculation, for three years later—in 1819—we find him bringing fresh evidence and argument to strengthen his startling hypothesis. His notes are now more extended, and they show that in the intervening three years he had thought much and deeply on this higher form of matter. He first points out that matter may be classed into four states—solid, liquid, gaseous, and radiant—these modifications depending upon differences in their several essential properties. He admits that the existence of radiant matter is as yet unproved, and then proceeds, in a series of ingenious analogical arguments, to show the probability of its existence.[2]

If, in the beginning of this century, we had asked, What is a gas? the answer then would have been that it is matter, expanded and rarefied to such an extent as to be impalpable, save when set in violent motion; invisible, incapable of assuming or of being reduced into any definite form like solids, or of forming drops like liquids; always ready to expand where no resistance is offered, and to contract on being subjected to pressure. Sixty years ago such were the chief attributes assigned to gases. Modern research, however, has greatly enlarged and modified our views on the constitution of these elastic fluids. Gases are now considered to be composed of an almost infinite number of small particles or molecules, which are constantly moving in every direction with velocities of all conceivable magnitudes. As these molecules are exceedingly numerous, it follows that no molecule can move far in any direction without coming in contact with some other molecule. But if we exhaust the air or gas contained in a closed vessel, the number of molecules becomes diminished, and the distance through which any one of them can move without coming in contact with another is increased, the length of the mean free path being inversely proportional to the number of molecules present. The further this process is carried the longer becomes the average distance a molecule can travel before entering into collision; or, in other words, the longer its mean free path the more the physical properties of the gas or air are modified. Thus, at a certain point, the phenomena of the radiometer become possible, and on pushing the rarefaction still further, *i.e.*, decreasing the number of molecules in a given space and lengthening their mean free path, the experimental results are obtainable to which I am now about to call your attention. So distinct are these phenomena from anything which occurs in air or gas at the ordinary tension, that we are led to assume that we are here brought face to face with matter in a fourth state or condition, a condition as far removed from the state of gas as a gas is from a liquid.

[1] A lecture delivered to the British Association for the Advancement of Science, at Sheffield, Friday, August 22, 1879, by William Crookes, F.R.S.

[2] "I may now notice a curious progression in physical properties accompanying changes of form, and which is perhaps sufficient to induce, in the inventive and sanguine philosopher, a considerable degree of belief in the association of the radiant form with the others in the set of changes I have mentioned.

"As we ascend from the solid to the fluid and gaseous states, physical properties diminish in number and variety, each state losing some of those which belonged to the preceding state. When solids are converted into fluids, all the varieties of hardness and softness are necessarily lost. Crystalline and other shapes are destroyed. Opacity and colour frequently give way to a colourless transparency, and a general mobility of particles is conferred.

"Passing onward to the gaseous state, still more of the evident characters of bodies are annihilated. The immense differences in their weight almost disappear; the remains of difference in colour that were left are lost. Transparency becomes universal, and they are all elastic. They now form but one set of substances, and the varieties of density, hardness, opacity, colour, elasticity, and form, which render the number of solids and fluids almost infinite, are now supplied by a few slight variations in weight, and some unimportant shades of colour.

"To those, therefore, who admit the radiant form of matter, no difficulty exists in the simplicity of the properties it possesses, but rather an argument in their favour. These persons show you a gradual resignation of properties in the matter we can appreciate as the matter ascends in the scale of forms, and they would be supnsed if that effect were to cease at the gaseous state. They point out the greater exertions which nature makes at each step of the change, and think that, consistently, it ought to be greatest in the passage from the gaseous to the radiant form."—*Life and Letters of Faraday*, vol. i. p. 308.

Mean Free Path. Radiant Matter

I have long believed that a well-known appearance observed in vacuum tubes is closely related to the phenomena of the mean free path of the molecules. When the negative pole is examined while the discharge from an induction-coil is passing through an exhausted tube, a dark space is seen to surround it. This dark space is found to increase and diminish as the vacuum is varied, in the same way that the mean free path of the molecules lengthens and contracts. As the one is perceived by the mind's eye to get greater, so the other is seen by the bodily eye to increase in size; and if the vacuum is insufficient to permit much play of the molecules before they enter into collision, the passage of electricity shows that the "dark space" has shrunk to small dimensions. We naturally infer that the dark space is the mean free path of the molecules of the residnal gas, an inference confirmed by experiment.

I will endeavour to render this "dark space" visible to all present. Here is a tube (Fig. 1) having a pole in the centre in

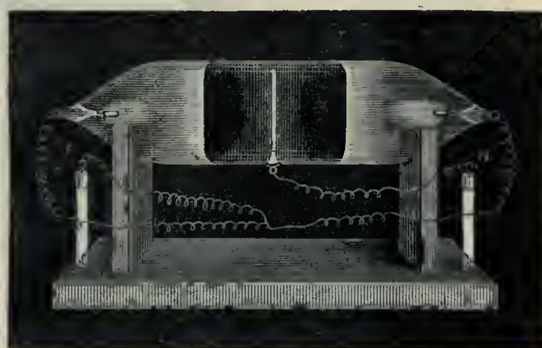

Fig. 1.

the form of a metal disk, and other poles at each end. The centre pole is made negative, and the two end poles connected together are made the positive terminal. The dark space will be in the centre. When the exhaustion is not very great the dark space extends only a little on each side of the negative pole in the centre. When the exhaustion is good, as in the tube before you, and I turn on the coil, the dark space is seen to extend for about an inch on each side of the pole.

Here, then, we see the induction spark actually illuminating the lines of molecular pressure caused by the excitement of the negative pole. The thickness of this dark space is the measure of the mean free path between successive collisions of the molecules of the residual gas. The extra velocity with which the negatively electrified molecules rebound from the excited pole, keeps back the more slowly moving molecules which are advancing towards that pole. A conflict occurs at the boundary of the dark space, where the luminous margin bears witness to the energy of the discharge.

Therefore the residual gas—or, as I prefer to call it, the gaseous residue—within the dark space, is in an entirely different state to that of the residual gas in vessels at a lower degree of exhaustion. To quote the words of our last year's President, in his address at Dublin:—

"In the exhausted column we have a vehicle for electricity not constant like an ordinary conductor, but itself modified by the passage of the discharge, and perhaps subject to laws differing materially from those which it obeys at atmospheric pressure."

In the vessels with the lower degree of exhaustion, the length of the mean free path of the molecules is exceedingly small as compared with the dimensions of the bulb, and the properties belonging to the ordinary gaseous state of matter, depending upon constant collisions, can be observed. But in the phenomena now about to be examined, so high is the exhaustion carried that the dark space around the negative pole has widened out till it entirely fills the tube. By great rarefaction the mean free path

has become so long that the hits in a given time in comparison to the misses may be disregarded, and the average molecule is now allowed to obey its own motions or laws without interference. The mean free path, in fact, is comparable to the dimensions of the vessel, and we have no longer to deal with a *continuous* portion of matter, as would be the case were the tubes less highly exhausted, but we must here contemplate the molecules *individually*. In these highly exhausted vessels the molecules of the gaseous residue are able to dart across the tube with comparatively few collisions, and radiating from the pole with enormous velocity, they assume properties so novel and so characteristic as to entirely justify the application of the term borrowed from Faraday, that of *Radiant Matter*.

Radiant Matter exerts powerful Phosphorogenic Action where it strikes

I have mentioned that the radiant matter within the dark space excites luminosity where its velocity is arrested by residual gas outside the dark space. But if no residual gas is left, the molecules will have their velocity arrested by the sides of the glass; and here we come to the first and one of the most noteworthy properties of radiant matter discharged from the negative pole—its power of exciting phosphorescence when it strikes against solid matter. The number of bodies which respond luminously to this molecular bombardment is very great, and the resulting colours are of every variety. Glass, for instance, is highly phosphorescent when exposed to a stream of radiant matter. Here (Fig. 2) are three bulbs composed of different glass: one is uranium glass (*a*), which phosphoresces of a dark green colour; another is English glass (*b*), which phosphoresces of a blue colour; and the third (*c*) is soft German glass—of which most of the apparatus before you is made—which phosphoresces of a bright apple-green.

My earlier experiments were almost entirely carried on by the aid of the phosphorescence which glass takes up when it is under the influence of the radiant discharge; but many other substances possess this phosphorescent power in a still higher degree than glass. For instance, here is some of the luminous sulphide of calcium prepared according to M. Ed. Becquerel's description. When the sulphide is exposed to light—even candle-light—it phosphoresces for hours with a bluish-white colour. It is, however, much more strongly phosphorescent to the molecular discharge in a good vacuum, as you will see when I pass the discharge through this tube.

Other substances besides English, German, and uranium glass, and Becquerel's luminous sulphides, are also phosphorescent.

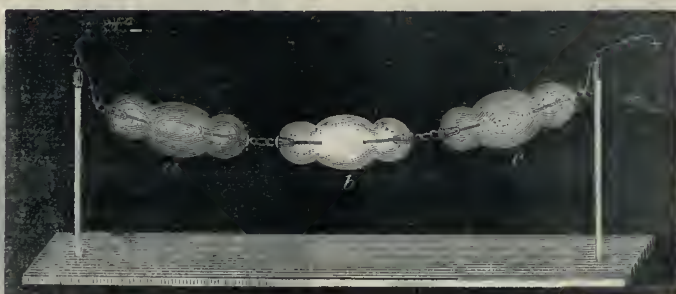

FIG. 2.

The rare mineral phenakite (aluminate of glucinum) phosphoresces blue; the mineral spodumene (a silicate of aluminium and lithium) phosphoresces a rich golden yellow; the emerald gives out a crimson light. But without exception, the diamond is the most sensitive substance I have yet met for ready and brilliant phosphorescence. Here is a very curious fluorescent diamond,

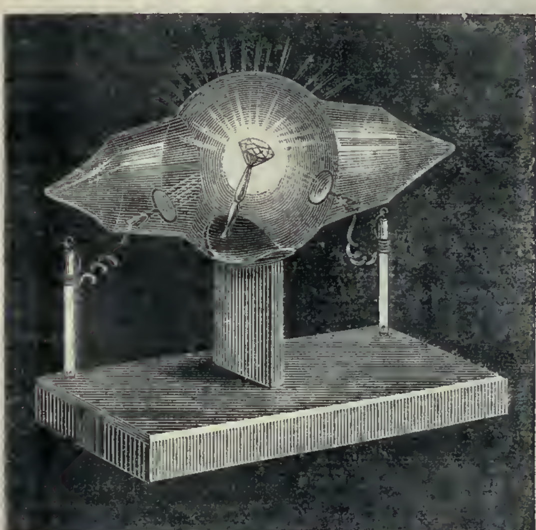

FIG. 3.

green by daylight, colourless by candle-light. It is monnted in the centre of an exhausted bulb (Fig. 3), and the molecular discharge will be directed on it from below upwards. On darkening the room you see the diamond shines with as much light as a candle, phosphorescing of a bright green.

Next to the diamond the ruby is one of the most remarkable stones for phosphorescing. In this tube (Fig. 4) is a fine collection of ruby pebbles. As soon as the induction-spark is turned on you will see these rubies shining with a brilliant rich red tone, as if they were glowing hot. It scarcely matters what colour the ruby is, to begin with. In this tube of natural rubies there are stones of all colours—the deep red and also the pale pink ruby. There are some so pale as to be almost colourless, and some of the highly-prized tint of pigeon's blood; but under the impact of radiant matter they all phosphoresce with about the same colour.

Now the ruby is nothing but crystallised alumina with a little

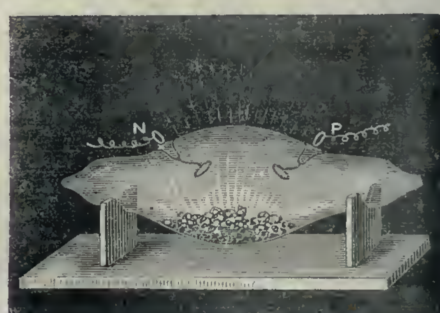

FIG. 4.

colouring-matter. In a paper by Ed. Becquerel,[1] published twenty years ago, he describes the appearance of alumina as glowing with a rich red colour in the phosphoroscope. Here is some precipitated alumina prepared in the most careful manner. It has been heated to whiteness, and you see it also glows under the molecular discharge with the same rich red colour.

The spectrum of the red light emitted by these varieties of alumina is the same as described by Becquerel twenty years ago. There is one intense red line, a little below the fixed line B in

[1] *Annales de Chimie et de Physique*, 3rd series, vol. lvii., p. 50, 1859.

the spectrum, having a wave-length of about 6895. There is a continuous spectrum beginning at about B, and a few fainter lines beyond it, but they are so faint in comparison with this red line that they may be neglected. This line is easily seen by examining with a small pocket spectroscope the light reflected from a good ruby.

There is one particular degree of exhaustion more favourable than any other for the development of the properties of radiant matter which are now under examination. Roughly speaking, it may be put at the millionth of an atmosphere.[1] At this degree of exhaustion the phosphorescence is very strong, and after that it begins to diminish until the spark refuses to pass.[2]

I have here a tube (Fig. 5) which will serve to illustrate the

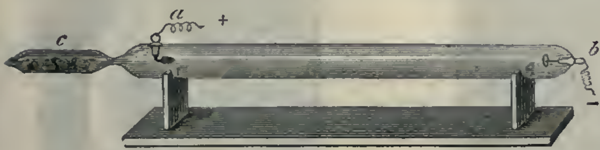

FIG. 5.

dependence of the phosphorescence of the glass on the degree of exhaustion. The two poles are at *a* and *b*, and at the end (*c*) is a small supplementary tube, connected with the other by a narrow aperture, and containing solid caustic potash. The tube has been exhausted to a very high point, and the potash heated so as to drive off moisture and injure the vacuum. Exhaustion has then been recommenced, and the alternate heating and exhaustion repeated until the tube has been brought to the state in which it now appears before you. When the induction-spark is first turned on nothing is visible—the vacuum is so high that the tube is non-conducting. I now warm the potash slightly, and liberate a trace of aqueous vapour. Instantly conduction commences, and the green phosphorescence flashes out along the length of the tube. I continue the heat, so as to drive off more gas from the potash. The green gets fainter, and now a wave of cloudy luminosity sweeps over the tube, and stratifications appear, which rapidly get narrower, until the spark passes along the tube in the form of a narrow purple line. I take the lamp away, and allow the potash to cool; as it cools, the aqueous vapour, which the heat had driven off, is re-absorbed. The purple line broadens out, and breaks up into fine stratifications; these get wider, and travel towards the potash tube. Now a wave of green light appears on the glass at the other end, sweeping on and driving the last pale stratification into the potash; and now the tube glows over its whole length with the green phosphorescence. I might keep it before you, and show the green growing fainter and the vacuum becoming non-conducting, but I should detain you too long, as time is required for the absorption of the last traces of vapour by the potash, and I must pass on to the next subject.

Radiant Matter proceeds in straight Lines

The radiant matter whose impact on the glass causes an evolution of light, absolutely refuses to turn a corner. Here is a V-shaped tube (Fig. 6), a pole being at each extremity. The pole at the right side (*a*) being negative, you see that the whole of the right arm is flooded with green light, but at the bottom it stops sharply and will not turn the corner to get into the left side. When I reverse the current and make the left pole negative, the green changes to the left side, always following the negative pole and leaving the positive side with scarcely any luminosity.

In the ordinary phenomena exhibited by vacuum tubes—phenomena with which we are all familiar—it is customary, in order to bring out the striking contrasts of colour, to bend the tubes into very elaborate designs. The luminosity caused by the phosphorescence of the residual gas follows all the convolutions into which skilful glass-blowers can manage to twist the glass. The

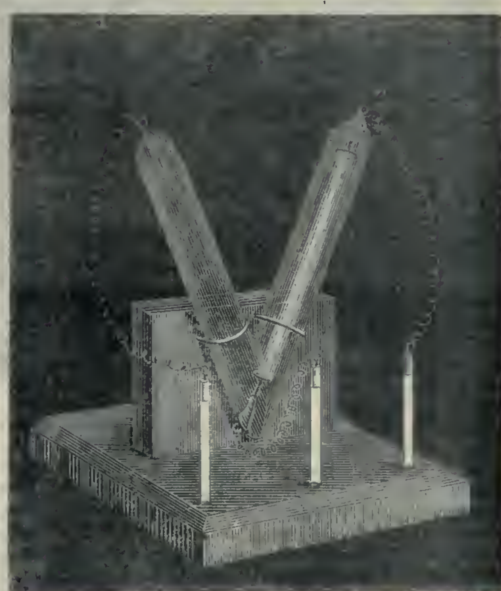

FIG. 6.

negative pole being at one end and the positive pole at the other, the luminous phenomena seem to depend more on the positive than on the negative at the ordinary exhaustion hitherto used to get the best phenomena of vacuum tubes. But at a very high exhaustion the phenomena noticed in ordinary vacuum tubes when the induction spark passes through them—an appearance of cloudy luminosity and of stratifications—disappear entirely. No cloud or fog whatever is seen in the body of the tube, and with such a vacuum as I am working with in these experiments, the only light observed is that from the phosphorescent surface of the glass. I have here two bulbs (Fig. 7), alike in shape and position of poles, the only difference being that one is at an exhaustion equal to a few millimetres of mercury—such a moderate exhaustion as will give the ordinary luminous phenomena—whilst the other is exhausted to about the millionth of an atmosphere. I will first connect the moderately exhausted bulb (A) with the induction-coil, and retaining the pole at one side (*a*) always negative, I will put the positive wire successively to the other poles with which the bulb is furnished. You see that as I change the position of the positive pole, the line of violet light joining the two poles changes, the electric current always choosing the shortest path between the two poles, and moving about the bulb as I alter the position of the wires.

This, then, is the kind of phenomenon we get in ordinary exhaustions. I will now try the same experiment with a bulb (B)

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[1]

1·0 millionth of an atmosphere	=	0·00076 millim.
1315·789 millionths of an atmosphere	=	1·0 millim.
1,000,000 " " "	=	760·0 millims.
" " " "	=	1 atmosphere.

[2] Nearly 100 years ago Mr. Wm. Morgan communicated to the Royal Society a paper entitled "Electrical Experiments made to ascertain the Non-conducting Power of a Perfect Vacuum, &c." The following extracts from this paper, which was published in the *Phil. Trans.* for 1785 (vol. lxxv. p. 272), will be read with interest:—

"A mercurial gage about 15 inches long, carefully and accurately boiled till every particle of air was expelled from the inside, was coated with tin-foil 5 inches down from its sealed end, and being inverted into mercury through a perforation in the brass cap which covered the mouth of the cistern; the whole was cemented together, and the air was exhausted from the inside of the cistern through a valve in the brass cap, which, producing a perfect vacuum in the gage, formed an instrument peculiarly well adapted for experiments of this kind. Things being thus adjusted (a small wire having been previously fixed on the inside of the cistern to form a communication between the brass cap and the mercury, into which the gage was inverted) the coated end was applied to the conductor of an electrical machine, and notwithstanding every effort, neither the smallest ray of light, nor the slightest charge, could ever be procured in this exhausted gage."

"If the mercury in the gage be imperfectly boiled, the experiment will not succeed; but the colour of the electric light, which, in air rarefied by an exhauster, is always violet or purple, appears in this case of a beautiful green, and, what is very curious, the degree of the air's rarefaction may be nearly determined by this means; for I have known instances, during the course of these experiments, where a small particle of air, having found its way into the tube, the electric light became visible, and, as usual, of a green colour; but the charge being often repeated, the gage has at length cracked at its sealed end, and in consequence the external air, by being admitted into the inside, has gradually produced a change in the electric light from green to blue, from blue to indigo, and so on to violet and purple, till the medium has at length become so dense as no longer to be a conductor of electricity. I think there can be little doubt, from the above experiments, of the non-conducting power of a perfect vacuum."

"This seems to prove that there is a limit even in the rarefaction of air, which sets bounds to its conducting power; or, in other words, that the particles of air may be so far separated from each other as no longer to be able to transmit the electric fluid; and if they are brought within a certain distance of each other their conducting power begins, and continually increases till their approach also arrives at its limit."

that is very highly exhausted, and as before, will make the side pole (a') the negative, the top pole (b) being positive. Notice how widely different is the appearance from that shown by the last bulb. The negative pole is in the form of a shallow cup. The molecular rays from the cup cross in the centre of the bulb, and thence diverging fall on the opposite side and produce a circular patch of green phosphorescent light. As I turn the bulb round you will all be able to see the green patch on the glass. Now observe, I remove the positive wire from the top, and connect it with the side pole (c). The green patch from the divergent negative focus is there still. I now make the lowest pole (d) positive, and the green patch remains where it was at first, unchanged in position or intensity.

We have here another property of radiant matter. In the low vacuum the position of the positive pole is of every importance, whilst in a high vacuum the position of the positive pole scarcely matters at all; the phenomena seem to depend entirely on the negative pole. If the negative pole points in the direction of the positive, all very well, but if the negative pole is entirely in the opposite direction it is of little consequence: the radiant matter darts all the same in a straight line from the negative.

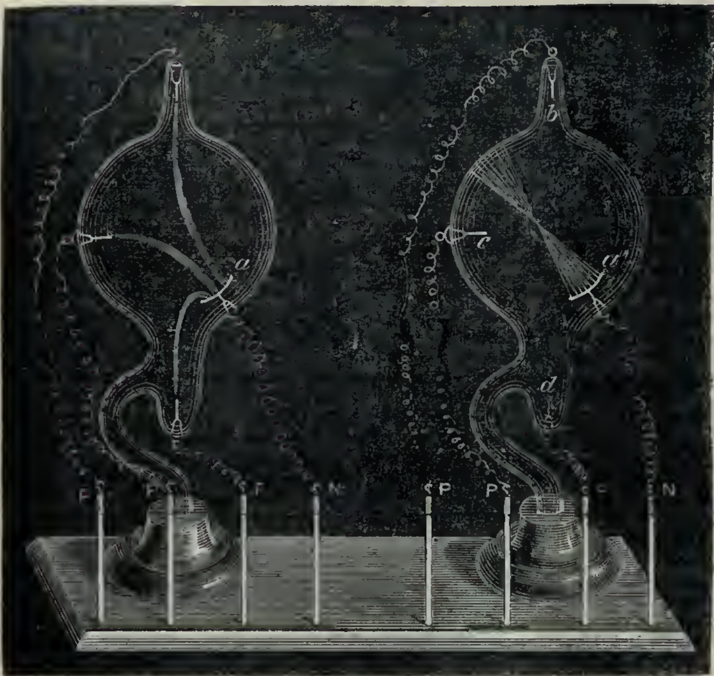


FIG. 7.

FIG. 8.

If, instead of a flat disk, a hemi-cylinder is used for the negative pole, the matter still radiates normal to its surface. The tube before you (Fig. 8) illustrates this property. It contains, as a negative pole, a hemi-cylinder (a) of polished aluminium. This is connected with a fine copper wire, b, ending at the platinum terminal, c. At the upper end of the tube is another terminal, d. The induction-coil is connected so that the hemi-cylinder is negative and the upper pole positive, and when exhausted to a sufficient extent the projection of the molecular rays to a focus is very beautifully shown. The rays of matter being driven from the hemi-cylinder in a direction normal to its surface, come to a focus and then diverge, tracing their path in brilliant green phosphorescence on the surface of the glass.

Instead of receiving the molecular rays on the glass, I will show you another tube in which the focus falls on a phosphorescent screen. See how brilliantly the lines of discharge shine out, and how intensely the focal point is illuminated, lighting up the table.

Radiant Matter when intercepted by Solid Matter casts a Shadow

Radiant matter comes from the pole in straight lines, and does not merely permeate all parts of the tube and fill it with light, as would be the case were the exhaustion less good. Where there is nothing in the way the rays strike the screen and produce phosphorescence, and where solid matter intervenes they are obstructed by it, and a shadow is thrown on the screen. In this pear-shaped bulb (Fig. 9) the negative pole (a) is at the pointed end. In the middle is a cross (b) cut out of sheet aluminium, so that the rays from the negative pole projected along the tube will be partly intercepted by the aluminium cross, and will project an image of it on the hemispherical end of the tube which is phosphorescent. I turn on the coil, and you will all see the black shadow of the cross on the luminous end of the bulb (c, d). Now, the radiant matter from the negative pole has been passing by the side of the aluminium cross to produce the shadow; the glass has been hammered and bombarded till it is appreciably warm, and at the same time another effect has been produced on the glass—its sensibility has been deadened. The glass has got tired, if I may use the expression, by the enforced phosphorescence. A change has been produced by this molecular bom-

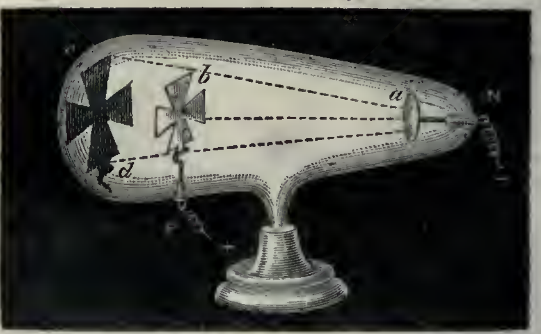


FIG. 9.

bardment which will prevent the glass from responding easily to additional excitement; but the part that the shadow has fallen on is not tired—it has not been phosphorescing at all and is perfectly fresh; therefore if I throw down this cross—I can easily do so by giving the apparatus a slight jerk, for it has been most ingeniously constructed with a hinge by Mr. Gimingham—and so allow the rays from the negative pole to fall uninterruptedly on to the end of the bulb, you will suddenly see the black cross

(*c*, *d*, Fig. 10) change to a luminous one (*e*, *f*), because the background is now only capable of faintly phosphorescing, whilst the part which had the black shadow on it retains its full phosphorescent power. The stencilled image of the luminous cross unfortunately soon dies out. After a period of rest the glass partly recovers its power of phosphorescing, but it is never so good as it was at first.

Here, therefore, is another important property of radiant matter. It is projected with great velocity from the negative pole, and not only strikes the glass in such a way as to cause it to vibrate and become temporarily luminous while the discharge is going on, but the molecules hammer away with sufficient energy to produce a permanent impression upon the glass.

(*To be continued.*)

NOTES

In accordance with the resolution come to at the recent International Congress of Meteorology, the International Committee have issued circulars for a special Conference at the Deutsche Seewarte at Hamburg, on October 1, to consider the scheme of Count Wilczek and Lieut. Weyprecht for the establishment of circumpolar observing stations. The Conference will consider specially the following points:—1. The number of observatories and the most convenient places at which to establish them. The decision will depend on the number of co-operating states and the sums which they are willing to devote to this purpose. Count Wilczek and Lieut. Weyprecht have proposed the following places:—In the Northern Hemisphere: north coasts of Spitzbergen and of Novaya Zemlya, the neighbourhood of the North Cape, the mouth of the Lena, New Siberia, Point Barrow, on the north-east of Behring Strait, west coast of Greenland, east coast of Greenland, about 75° N. lat. In the Southern Hemisphere: the neighbourhood of Cape Horn, Kerguelen or Macdonald Islands, one of the groups south of the Auckland Islands. 2. There will be considered the exact epoch of the observations and their maximum duration. 3. Uniform instruction for observations, which will have to fix especially: (*a*) The minimum of elements to be observed at each station, both for meteorological phenomena and for those of terrestrial magnetism, as well as for other phenomena of terrestrial physics connected with them. (*b*) The minimum number of daily observations for the different elements. (*c*) The first meridian which will serve as basis for simultaneous observations. (*d*) Methods of observation for the different elements and methods of reduction. (*e*) Instruments of observation and their arrangement, as far as they may influence the comparability of the results.

At a recent meeting of the Committee of the Iron and Steel Institute in Liverpool it was arranged that this year's meeting should be held in Liverpool on September 24, 25, and 26. The use of St. George's Hall has been granted by the Corporation, and numerous places for inspection and excursion have been partly arranged for, including Messrs. Blundell's collieries, near Wigan, and the Tubular Bridge at Menai Straits. In addition to papers on the manufacture and application of steel and iron, papers on subjects of work more immediately connected with Liverpool have been promised.

M. Janssen, we are glad to see, has been appointed to represent the Paris Academy of Sciences, at the inauguration of the statue to Arago, at Perpignan.

The prizes instituted by Prof. Schäfli (Lausanne) for scientific works on Switzerland will now be awarded not only to Swiss naturalists, as hitherto, but also to foreign, a resolution in this sense having been accepted at the last meeting of Swiss naturalists.

We regret to hear of the death of Mr. Edward Edwards, late of Menai Bridge, Anglesey, at the age of seventy-five. For upwards of twenty years he had studied the habits and characters of marine animals in their native haunts, and his contrivance of the "dark chamber tank" was the first by which these animal, could be kept alive and healthy for an indefinite period in confinement, and the principle of which was afterwards carefully recognised in the construction of the Crystal Palace and other aquariums.

The *Times* Geneva correspondent writes, under date August 22:—"On the evening of August 5, six persons who were standing in the gallery of a *châlet* in the Jura, above St. Cergues, witnessed an atmospheric phenomenon equally rare and curious. The aspect of the sky was dark and stormy. The air was thick with clouds, out of which darted at intervals bright flashes of lightning. At length one of these clouds, seeming to break loose from the mountains between Nyon and the Dôle, advanced in the direction of a storm which had, meanwhile, broken out over Morges. The sun was hidden and the country covered with thick darkness. At this moment the pine forest round St. Cergues was suddenly illuminated and shone with a light bearing a striking resemblance to the phosphorescence of the sea as seen in the tropics. The light disappeared with every clap of thunder, but only to re-appear with increased intensity until the subsidence of the tempest. M. Raoul Pictet, the eminent chemist, who was one of the witnesses of the phenomenon, thus explains it in the last number of the *Archives des Sciences Physiques et Naturelles*:—'Before the appearance of this fire of St. Elmo, which covered the whole of the forest, it had rained several minutes during the first part of the storm. The rain had converted the trees into conductors of electricity. Then, when the cloud, strongly charged with the electric fluid, passed over this multitude of points, the discharges were sufficiently vivid to give rise to the luminous appearance. The effect was produced by the action of the electricity of the atmosphere on the electricity of the earth, an effect which, on the occasion in question, was considerably increased by the height of the locality, the proximity of a storm-cloud, and the action of the rain, which turned all the trees of the forest into conductors.'"

A young female gorilla is now being exhibited at the Crystal Palace.

At the last meeting of the Swiss Naturalists, Prof. Kollmann (Basel) presented a report of the Anthropological and Statistical Commission, appointed by the Swiss Natural History Society for the investigation of the distribution of the light-coloured and dark-coloured population in Switzerland. Thanks to the collaboration of many schoolmasters, no less than 250,000 children in twenty-one cantons were described as to the colour of the eyes, hair, and skin, and a very rich and reliable material was collected. It is proved that in Switzerland, as well as in all middle Europe, the light-coloured population decreases from north to south, while the dark-coloured increases, and that it reaches its greatest quantity in the Graubünden, sending a rather dense branch to the south-west. It may be concluded that a dark-coloured population immigrated in Switzerland from the south, having also a side-branch which followed the direction from the Rhone to the Rhine.

We are glad to learn that the great undertaking of printing and publishing a catalogue of the Advocates' Library, Edinburgh, which has been in progress for many years, is now approaching completion. The Library of the Faculty of Advocates ranks next to the British Museum and the Bodleian among the libraries of the United Kingdom. It contains about 262,000 printed volumes, besides manuscripts of great interest and importance. It has had (under the Copyright Act) since the reign of Queen Anne the right of receiving a copy of every book published in the United Kingdom. Last year there were added to the Library 4,007 volumes of books, besides periodicals, pamphlets, and

music. The Catalogue consists of six volumes and supplement —containing over 200,000 entries—and extending to more than 5,500 quarto pages in double columns. Some idea of the expense of making and printing such a catalogue may be formed from the fact that individual Members of Faculty have already contributed, in donations and subscriptions, a sum of 3,700*l.* About 250*l.* are still required to print the supplement. It is expected that the work will be completed in September next, and the Advocates' Library will then be the only great library in the world possessing a complete printed catalogue. The value of this work will consist not merely in its making known the peculiar treasures of the library, but in its being the only approximately complete catalogue of all works published in the United Kingdom since the reign of Queen Anne, arranged not merely in the alphabetical order of the authors' names, but to a considerable extent also under leading subjects. Further, more information will be found in it on anonymous and pseudonymous English and Scotch literature than in any other catalogue; and a more extensive analysis of historical and other collections than can be had anywhere else. As regards biographical information, there will be found under each author's name cross-references to all books in the Library written about him or his works. We believe the Library has also a fair collection of scientific works. A copy can be had by addressing "The Keeper of the Advocates' Library, Edinburgh."

IT is with pleasure that we announce the completion of the second edition of "Die Urwelt der Schweiz," by Oswald Heer. Herr Schulthess, of Zurich, is the publisher.

IN its *Jahresbericht* for 1878 the "Bienenwirthschaftliche Hauptverein im Königreiche Sachsen" publishes the following highly interesting statistical data referring to the indirect utility of bees:—It has ever been one of the objects of all apicultural societies to prove the great importance of bees to agriculture generally. It appears that the Society named possesses 17,000 hives from each of which 10,000 bees fly out daily, which represents a total of 170 millions of bees. If we suppose that each bee undertakes but four journeys per day and that this takes place only on 100 days out of the 365, then we obtain a yearly total of 68,000 millions of bee-journeys. It is not too much to suppose that fifty flowers are visited on each journey, and we are certainly justified in supposing that five out of these fifty are fertilised; then we get a grand total of 340,000 millions of fertilised flowers per year. Let the value of fertilising 5,000 blossoms be but 1 pfennig (or 500,000 for 1*s.*), then the work done by bees of the society represents a value of 68 million pfennige, or 34,000*l.* sterling. It results from these calculations that each hive benefits agriculture to the amount of 2*l.* annually, a value which hitherto has been totally overlooked.

NEWS from Moscow states that a kind of subterranean conflagration is raging upon the islands and the shore of the Kurgaldschin lake in the district of Akmolinsk, province of Atbosarsk. It began in April last, and in the middle of June was still burning with unabated force. The fire spreads in the foot-deep layers of dry reeds, and has penetrated as far as the winter camps of the Kurgaldschin Wolostg, where some 120 Kirghise farms have perished through the flames.

AN international special exhibition of agricultural machinery, &c., will be held at Prague from September 27 to October 5 next.

THE well-known geologist Prof. Credner, has recently proved that in the western part of Saxony glaciers have formerly existed, by the discovery of numerous polished and grooved surfaces of porphyry rocks, now imbedded in the inundation deposits of more recent geological periods. From this discovery it seems that the Scandinavian ice at some epoch reached as far as the neighbourhood of Leipzig, *i.e.*, to the southern border of the North German plains.

NEAR Wildeshausen (Oldenburg) a so-called window-urn has been found in a prehistoric sepulchral mound. The urn is of elegant shape, perfectly smooth, only ten centimetres in height, and consists of bright gray fine clay. In the body of the urn there are three round holes of about two centimetres in diameter; into these holes green pieces of glass were let in when the clay was still moist. Another piece of glass is in the foot of the urn. Inside the urn stood a vase of the same material and almost the same height. The contents were bones and charcoal. Up to the present, as far as is known, only six window urns have been found; the one described would therefore be the seventh.

MR. MORRIS's recipe for the cure of the coffee-leaf disease in Ceylon appears to be the application of caustic lime in the proportion of two or three parts to one of flowers of sulphur. He maintains that the disease can only be successfully treated at one of its three stages—the filamentary—when the mixture described will kill the filaments. Mr. Morris is about to publish a handbook on the treatment of this scourge of the island, and by latest advices it appears probable that, at the earnest request of the planters, his departure from Ceylon to Jamaica will be indefinitely postponed.

THE *Echo du Japon* states that the works established at Tsukudu-shima for making carbonate of lime are proving very successful, and will, it is said, send a great quantity of the product to China.

NEAR the village of Eisenkappel (Carinthia), at the border of a forest, several new mineral springs have been discovered about the end of July. They originate in the bed of syenite granite which passes in the direction from Ebriach to Schwarzenbach, and are particularly rich in carbonate of soda, as well as in free and dissolved carbonic acid.

WE notice a very useful Russian pamphlet by M. Lukashevich, on arrangements for heating and ventilation, being a critical description of the various heating and ventilating apparatus exhibited at Cassel in 1877, during the first international exhibition of these apparatus. When we take into consideration how much remains to do in that branch of our knowledge, we cannot but welcome every good work on the subject.

THE *Report and Transactions* of the Cardiff Naturalists' Society for 1878, contains several scientific papers creditable to the members. The Society's Museum has been much improved.

A VOLUME of some interest in connection with progress in Spain has been published by Prof. A. Calderon Arana, "Movimento Novisimo de la Filosofia Natural en España." It is published at the Casa editorial de Medina, Madrid.

THE additions to the Zoological Society's Gardens during the past week include a Guinea Baboon (*Cynocephalus sphinx*) from West Africa, presented by Mr. P. Lembery; a Bush Dog (*Icticyon venaticus*) from British Guiana, presented by Mr. J. Ernest Tinne; a Ring-necked Parrakeet (*Palæornis torquatus*) from India, presented by Mrs. Watson; a Common Cuckoo (*Cuculus canorus*), British, presented by Mr. J. Sharpland; a Common Barn Owl (*Strix flammea*), British, presented by Mr. H. Norris; a Chacma Baboon (*Cynocephalus porcarius*) from South Africa, deposited; four Common Spoonbills (*Platalea leucorodia*), European, eighteen Chestnut-breasted Ducks (*Anas castanea*), an Adelaide Parrakeet (*Palæornis adelaida*) from Australia, purchased; a Cape Buffalo (*Bubalus caffer*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

DR. JOHANN LAMONT.—The death of Dr. Lamont, so long connected with the Royal Observatory of Munich (Bogenhausen), was mentioned last week. He was of Scotch extraction, and was born at Braemar on December 13, 1805. He was at first assistant at Munich, under Soldner, and was appointed director of the observatory in 1835, and Professor of Astronomy in the University of Munich in 1852. His name has, perhaps, been chiefly associated with terrestrial magnetism, his first publication on this subject being the "Handbuch des Erdmagnetismus," which appeared in 1838. In 1851 he wrote on the ten-year period of magnetic declination, of the existence of which he was an independent discoverer, and the same year he published at Stuttgart his "Astronomie und Erdmagnetismus," and a long series of memoirs bearing upon magnetical science is due to him. He is also the inventor of a set of instruments for determining the magnetic elements very widely used by continental magneticians. As an astronomer we find him occupied with the observation of Halley's comet with the refractor of eleven inches aperture, erected in 1835, by means of which he was able to follow the comet until May 17, 1836, nearly a fortnight later than it was seen by Sir John Herschel, with his 20-feet reflector, at the Cape of Good Hope, the last glimpse of the comet being thus obtained by Lamont. It was then distant from the earth 2·69, and from the sun 1·86, so that the intensity of light was almost precisely the same as when the comet was first detected by Dumouchel at Rome, August 5, 1835. In 1836 he calculated elements of the Saturnian satellites *Enceladus* and *Tethys*, which had been observed at Munich, and also discussed Sir W. Herschel's observations of the latter. In the summer of this year he measured the diameter of Pallas, and formed charts of stars in the clusters in Scutum and Perseus. In the following year he made a series of measures of the two brighter satellites of Uranus, and deduced from them a value of the mass of the primary considerably less than that previously adopted from Bouvard's tables. The most extensive astronomical work executed at Munich under Lamont's direction is the observations of zones of stars from + 15° to – 30° published in successive volumes of the *Annalen der k. Sternwarte bei München*, and in the previous series; various catalogues founded thereon, and containing together upwards of 30,000 stars reduced to the year 1850, have been published in the supplementary volumes of the Annals. Mr. Hind found in Lamont's zones two observations of Neptune before its planetary character was recognised. The magnitudes of the telescopic stars in these zones will prove serviceable from time to time in the investigations of the periods of variable stars.

THE SATELLITES OF MARS.—Prof. Asaph Hall, after discussing the long series of observations of the newly-discovered satellites of Mars made with the Washington 26-inch refractor in 1877, expressed the opinion that at the approaching opposition of the planet these objects will be observable with that instrument from about October 10 to November 29. It may therefore appear almost hopeless to expect measures as early as September, yet probably efforts may be made in this direction and with the view to facilitate the identification of the outer satellite, *Deimos*, we subjoin positions calculated from Prof. Hall's elements for 13h. Greenwich mean time :—

	Pos.	Dist.		Pos.	Dist.
	°	"		°	"
Sept. 11	235·5	48·5	Sept. 16	238·7	46·5
12	296·3	10·3	17	8·5	12·7
13	49·9	46·9	18	53·1	51·7
14	68·3	30·0	19	80·0	19·8
15	221·6	33·2	20	227·1	43·6

The greatest elongations of the satellites occur at angles of about 53° and 233°, the greatest apparent distances at the next opposition being 67" for *Deimos* and 27" for *Phobos*, the former passing the extremity of the minor-axis of the ellipse about seven seconds distant from the limb of the planet.

GEOGRAPHICAL NOTES

HERR OTTO SCHÜTT, the well-known African traveller, has returned to Lisbon from his exploring expedition to Central Africa, undertaken by order of the German African Society, and has delivered an interesting lecture to the Lisbon Geographical Society. He brings home highly important and quite new data concerning the complicated hydrography of the Congo Basin. Between the Cuango and the Casai rivers, two known tributaries of the Congo, he has discovered four others, viz., the Quengo, Marata, Cinlu and Quanger rivers. Besides this he has determined the upper course of the Casai river from lat. 8° S. to about lat. 6° S. in a district totally unknown hitherto. From lat. 8° S. as far as lat. 4° S. the Casai takes the name of Zaïre, which on older maps is often given to the Congo itself. The lake called Sankowa Lake by English explorers is situated in lat. 5° S., and is called Mucaruba by the natives. To the south of this lake a tribe of dwarfs are living. The tribes inhabiting the shores of the Quengo and the Casai rivers are cannibals. As the Muata Jamvo, who some three years ago stopped Pogge's further progress, did not permit Herr Schütt to cross the Lulua river, he had to return to Loanda on the west coast.

IT is announced from Sierra Leone that Mr. H. M. Stanley arrived there on July 24, and left on August 1 for "Banana" (? Mboma), on the Congo.

INTELLIGENCE has been received at New York of the arrival of the Polar exploring vessel *Jeannette* at Onalaska, on the 2nd inst. She is to endeavour to meet with Nordenskjöld in Behring Strait. The United States Revenue vessel *Richard Rush* has passed through Behring Strait, within seventy-five miles of East Cape. Her captain reports that the sea northward of that point is clear of ice. Last winter had been unusually warm, and the ice broke up earlier than usual.

SEVERAL Russian expeditions are to be sent out during this autumn to Central Asia, and especially to the Darwaz. Capt. Hermann and the well-known young botanist, M. Smirnoff, will explore that quite unknown country, and M. Smirnoff will no doubt bring back a rich botanical collection.

A TELEGRAM has reached St. Petersburg through Pekin from Col. Prjwalsky, to the effect that at the date of his despatch his expedition had accomplished the third part of the route to the Himalaya, and that no great obstacles were expected to intervene between them and their desired goal—which may mean Lhassa.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

How did Eozoon Originate, and is Graphite a Proof of Organic Beings in the Laurentian Period?

I READ with great interest the abstract of Dr. Moebius's investigations on Eozöon in NATURE, vol. xx. pp. 272, 297, and no more doubt of its inorganic origin. But how was Eozöon formed? We find such single or ramified foraminiferæ-like or algæ-like fibres or stems (Figs. 5, 9, 10, 18, 19), which show,

by their irregularity, that all organic origin is excluded, sometimes in ice; they originate in the hardening together of crystals, under pressure, and are only the imprisoned, often stem-like and branded hollows of air. Like Eozöon they become afterwards filled with foreign matter, with serpentine and chrysotile, resulting out of the watery decomposition of olivine.

To show how analogous circumstances are also applicable to the origin of Eozöon, I shall first refute the two erroneous arguments often adduced for the organic existence in the laurentian period: the presence of graphite and the stratification of the oldest rocks.

Graphite, as Dr. Moebius supposes, cannot be a sign of primitive organic life. (1) In the oldest period there certainly lived only the most primitive lower beings, which without exception decay rapidly, and are therefore not able to furnish coal. (2) Graphite is sometimes a substitute of mica in the Gneiss; if it be phytogen, the synchronous quartz and feldspar, &c., must also be declared so; but that is absurd. (3) We always get amorphous coal out of organic beings, and by chemical process in the cold way, and on the contrary crystallised coal, *i.e.* graphite, is only to be produced by heat, and in several ways, even out of gases. We must regard graphite as one of the arguments, proving the incandescent origin of the oldest rocks. Out of each kind of coal, also of graphite, bitumen can originate, so that bitumen is not always a sure proof of organic beings. (4) There exist many other facts proving the incandescent origin of laurentian minerals; I will add, as I believe, a new one. This origin excludes at the same time any living beings. Not one original mineral of the laurentian minerals contains water, only mica contains a very small proportion, but this chemically combined, for it cannot be expelled at red heat. If these minerals had not had their origin in heat, they would sometimes contain water.

The other fallacious proof for the neptunic origin of laurentian rocks is their occasional stratification, and this origin would include the possibility of organic beings. No geogenetic hypotheses have been able to combine the facts of heat origin and stratification! But if we change the generally adopted opinion of Kant and Laplace, that the gases of the atmokosmos formed our globe by being condensed first into incandescent liquids, and finally into *crystals*, we may combine all the facts.

It is often found that we get out of hot gases mostly crystals, which partly by chemical reaction, become at first incandescent, and even quartz, feldspar, granite, and some iron minerals that we find in the granite, are known to be produced crystallised out of gases. Other facts prove that these laurentian minerals must have originated between white and red heat.

In the origin of glaciers we have an analogy for the agglomeration of the incandescent crystals into the first earth-crust without melting, only by baking together, as being somewhat plastic, the crystals of snow harden together into ice, driving out the air between the crystals and loosing their crystallised surface, assuming also sometimes Eozöon-like forms. Glaciers not seldom show stratifications, especially in the upper part formed by temporary snow-falls. As on the top of the glacier the snow-crystals lie yet ununited, so the minerals of the laurentian period were certainly lying ununited upon the surface, and became afterwards hydrated together, when the earth-crust was cool enough, so that we find them in the post-laurentian period much more mixed and with products of neptunic erosion. OTTO KUNTZE

Leipzig-Eutritzsch, August 2

Unobserved Impressions

A NOTE to Mr. Mivart's address in the Biological Section of the British Association contains the following:—

"Having gazed vacantly through a window we revert to the pages of a manuscript we may be writing and see there the spectra of the window bars we had before unconsciously seen. Here the effect on the organism must have been similar to what it would have been had we attended to it—*i.e.*, it was unfelt sensation" (NATURE, vol. xx. p. 399).

The last words induce me to mention what I believe I have often observed but have hitherto presumed to be well known in psychophysics, because though they are not inconsistent with it they seem to show that it had escaped the speaker; namely, that an unobserved impression produces a much stronger effect on the organism immediately impressed than an observed impression. Of course the observation cannot be experimentally prepared; but if any one who experiences a case like that described by Mr. Mivart will allow the image to fade and then try to form another of the kind, he will be struck I believe by the inferiority of the voluntary one.

The phrase "unfelt sensation" suggests questions I wish to keep clear of; but the phenomenon appears to me interesting, because it plainly shows that work which would be done on the retina, or on something, by an unobserved impression, is done elsewhere by an observed one. C. J. MONRO

Chesterfield, August 24

Insect-Swarms

A WONDERFUL flight of insects has passed over here to-day, consisting of the butterfly *V. cardui* and the moth *P. gamma*. They all came from the sea from the north-west and passed over the land to the south-east. I first noticed the flight at 7.30 A.M. The morning was bright and sunny with a light wind a little south of east. Great numbers of *V. cardui* were soaring at all heights, up to at least 150 feet, above and between the poplars which surround the house in which I am staying; all were going leisurely to the south-east; lower down *P. gamma* more erratic in its flight, was going in numbers in the same direction. I went down on to the grassy slope above the shore cliff. The blackberry blossoms were covered with *V. cardui* and *P. gamma*, three or four ou a flower, the fussy moths much disturbing the more sedate butterflies, but each bent on holding its own. With scarcely an exception they took flight in a south-east direction when disturbed or when satisfied with their often, I fear, vain search for food. I stepped fifty paces from a clump of dark firs at right angles to their line of flight and counted the butterflies which passed for two intervals of two minutes; the numbers were 95 and 108, but I probably missed some of the higher ones. On the shore at 10 o'clock I counted 73 in one minute pass a space 50 paces in width; at 11.45 in one minute 50 passed the same space. The numbers of *P. gamma* were more difficult to ascertain owing to their smaller size and more erratic flight, but as they all flew very low on the shore, not more than a foot or two at most above the water or sand, I stepped 20 paces and tried to count the moths passing within those limits with the result—one minute 32 moths, two consecutive minutes 18 moths, again two minutes 120 at least. In the second interval a strong gust of wind checked the flight altogether, and in the third interval the moths came so fast that I missed many I feel sure. The *P. gamma* were evidently much exhausted; while bathing I saw several floating on the surface of the water, which took flight when touched or crawled on to a finger presented to them; some settled on me and on others while we were bathing. At 12 o'clock I passed uninterruptedly through the flight while walking from Trouville Harbour for a distance of two kilometres northwards along the shore. There was then an occasional white butterfly (*Pieris*) in the flight, and I also noticed two dragon-flies coming from the sea and following the same direction as the other insects; I noticed other dragon-flies with the flight inland, but they abound here. Had those coming from the sea accompanied the flight throughout as hawks are said to follow the flights of birds on which they prey? From the shore I climbed up the cliff, the grassy slopes above it were swarming with *P. gamma* and *V. cardui*, nearly every flower having one visitor at least. At 1.15 P.M. *P. gamma* passed over in undiminished numbers, but *V. cardui* was not so abundant. At 5.30 I rode parallel with the coast line along the Honfleur road to a point rather more than 10 kilometres from Trouville, passing through an uninterrupted flight of *P. gamma* all the way, but no *V. cardui*, though the butterfly still abounded on the blackberry and other blossoms by the roadside. Throughout the last two kilometres the moths were much fewer in number, but had not quite disappeared when I turned back. *P. gamma* generally flew lower than *V. cardui*, but the force which impelled them in one direction, as if their bodies were magnetised and their north pole was in the south-east, was so strong that when they met an obstruction to the course of their flight they went often over it not round it. While riding I noticed that they rose up and flew over isolated buildings, and I was curious to see whether they would do the same with a church tower. As I passed through Villerville, three came over the top of the church tower, and again at Criquebœuf, three fluttered up the wall, and flew over the church tower as I passed it. At 8 P.M. I went up on to the roof of the house; the moths were then flying up the front of the house and over the roof in great numbers. The flight of *P. gamma* continued to pass the

house in which I am writing, without interruption, from 7.30 A.M. till dark, and are now at 11.30 P.M., flying in at the open window, so as to be a perfect nuisance. They are still tired moths, for they soon settle; there are certainly many hundreds in the dark corners and along the cornice.[1] My children tell me that numbers of the moths were lying dead on the dry sand above high-water mark.[2] They collected some for a tame young magpie, which has been very happy all day among the flower-beds in the garden catching *P. gamma*, which, under ordinary conditions, would be far too wide awake for him.

How far the flight extended south of Trouville I do not know, but the number of insects which have passed from sea to land here to-day must be very great. Assuming that one *P. gamma* passed over each metre of shore line each minute, an estimate below the mark at all points to which my observation extended, and assuming the flight to have extended 10 kilometres along the shore, as I ascertained that it did during the evening, nearly 8,000,000 of *P. gamma* passed from sea to land between 7.30 A.M. and 8.30 P.M.

All the insects which I caught or looked at on flowers were in perfect condition.

Where have all these insects come from? Has the flight been noticed in England? *V. cardui* was exceedingly abundant here in June and throughout July, indeed it was the only butterfly to be seen in any numbers. Its larvæ have been feeding in tolerable numbers on the thistles and other plants, and some few fresh specimens appeared before the flight of to-day, but I think there is no doubt the insects which formed to-day's flight were not bred here. Why should the moth and the butterfly come together? Here they were flying against or nearly against, the wind, although they may have started with a favourable wind. Where will they go to? If they go far, what influence will they have on cross-fertilisation? The quantity of pollen which they will carry onwards from the myriads of flowers they have visited will be immense. Perhaps other observers may answer some of these questions. J. CLARKE HAWKSHAW

Trouville, Calvados, France, August 12

P.S.—The flight still continues this morning, August 13, 10 A.M.; *V. cardui* quite as abundant as yesterday.

P.S. No. 2.—The flight of *V. cardui* and *P. gamma*, described in my letter of August 12 ceased about 12 A.M. on the 13th. At 11 A.M. I counted forty-six and twenty-four *V. cardui* on the shore passing over a space of fifty yards in width, in two intervals each of two minutes. Judging from their number, the *V. cardui* have not remained here; on the other hand, I think many of the *P. gamma* have. On the 14th a large clearing in the forest of Tonques, about two miles inland, was alive with them. The flowers of the wood-sage appeared to be the great attraction there. I noticed many *P. gamma* lying dead on the roads inland, all in perfect condition. I believe that these moths died of starvation. The moths which flew into the house on the evening of the 12th were all more or less sluggish in the morning. There were more than 400 on one window, many of which readily took food offered to them in the form of syrup, and I induced a number of those in the forest to come on to my finger and suck up syrup.

What I have seen leads me to make the following suggestions as to the cause of these migrations of lepidoptera.

When a favourable season produces a great swarm of insects numbers would die from want of food if they remained where they came into existence, as the number of food-producing flowers is limited. To move off in some direction would be a necessity, and in time the impulse to migrate would become instinctive as soon as the want of food was felt, or even the presence of a crowd of their fellows. It would seem that the supply of food might be most readily found if the insects moved off in all directions, that is, spread from the centre of scarcity; but many moths seek their food by scent, and on that account generally, I believe, fly against the wind. Many facts might be given to show how acute the power of scent in moths is. Whether butterflies seek their food by scent or not I do not know; some are certainly attracted by strong odours, *Apatura iris*, for instance. At any rate, I think a hungry moth would fly against the wind, and so the general direction of a flight of moths might be determined.

Here both butterflies and moths searched the first flowers they came to after leaving the sea. The first comers would go on refreshed, but the later ones merely wasted their energy in a fruitless search, and many of the moths fell dead by the way.

In the case of the flight I have described, a double necessity for the migration would have arisen if the butterfly and the moth came into existence at the same time as, seeing their fine condition, they most probably did. As both appeared to search the same flowers, the dearth of food at their centre of departure would more speedily have arisen.—J. C. H.

August 23

[1] I have counted 200 on one part of the cornice.

[2] Possibly killed by the heat of the sand, on which they settled in an exhausted state.

Animal Rights

MR. ROMANES's parallel is as unsound as amusing. If a physiologist claimed to vivisect his children "on the plea that it was for this purpose that he had begotten them," we should tell him that the legal admission of such pleas would undermine human society. But in the killing of pigs for food no undermining of human society is involved. Moreover, we know that men breed pigs only to kill them, but that men breed children from entirely different motives; we should answer the physiologist that his plea was impossible of proof, that all human experience negatived its probability, and that consequently it could not be admitted to overrule his children's presumptive right of life.

Mr. Romanes repeats his amazing proposition in morals, that "if we have a moral right to slay a harmful animal in order to better our own condition, it involves an inconsistency to deny that we have a similar right to slay a harmlesss animal, if by so doing we can secure a similar end." Then, if we have a moral right to slay harmful Zulus to better our own condition, we have a similar right to slay harmless Eskimos, if by so doing we can secure a similar end!

Mr. Romanes says that I did not attempt to meet one of his criticisms. Had I thought I might, I would have met them all; it does not take long. He thinks a lobster, to whom might is right, could not convince a philosopher that the latter had no right to eat him. Then I may pick a thief's pocket? He next admits that the lobster might appeal to the philosopher's morality, but asks why "the right of an edible animal to live is superior to that of an eating animal to kill?" Then the right of a robbable man to his money is not superior to the right of a man who uses money to rob him? And I, who am edible, have no more right to live than a cannibal has to eat me? Lastly, Mr. Romanes makes his philosopher say that he prefers lobster salad and roast lamb to boiled snakes and rat pie. Preferences are not rights, but if they were I have not suggested that the latter diet should supersede the former; and so my withers are unwrung.

EDWARD B. NICHOLSON

[*Ergo* the rights of a pig are *not* the same as those of a baby, which is just the point which my purposely unsound parallel was intended to show. It is for Mr. Nicholson to prove that the parallel is *sound*, if he is to sustain his "erroneous premiss," that the rights of men and animals are identical (the objection as to "motive" I ignore, because on the erroneous premiss in question the physiologist's motive might be sincerely stated and adequately proved as *a* motive by a declaration, say, in the marriage settlements). Instead of doing so, however, he alludes to one important difference between the rights of an animal and those of a man—the difference, namely, which arises from the latter being a member of human society. And this difference is in itself sufficient to nullify the force of all his rejoinders. Only on Mr. Nicholson's own supposition, that the rights of all living things are identical, could any of my propositions made with reference to animals be tested by their applicability to men. But this is just the supposition which I regard as absurd, and because it seems to me that ethical doctrine is here sufficiently patent—viz., that man as an intellectual, moral, and social being has rights additional to those of a merely sentient being. I will not take any further part in this correspondence.]

GEORGE J. ROMANES

Alpine Clubs

IN your account of the late conference of Alpine clubs, held at Geneva, there is one little omission which, as interesting to the scientific world generally, I beg leave to remedy.

It was suggested by your humble servant that a re-publication of de Saussure's "Voyages dans les Alpes" would be an appropriate memorial of our little congress at the city of which he was, I may say yet is, so bright an ornament. My plan was to

add the matter necessary to bring his work up to date in science, within square brackets (as in Stephen's edition of "Blackstone's Commentaries"), or as notes, or even as an appendix, the whole work to be in the hands of an efficient committee. The proposition was very cordially received, and I should like to hear what English men of science think of the matter. The book is of the freshest, brightest nature; even as a small boy I delighted in it; and my own idea is that de Saussure, though necessarily behind the giant strides of modern knowledge, made so very few mistakes that re-publication would not have the same dangers for his reputation as it might for that of a mere mediocrity.

MARSHALL HALL

Vernex-Montreux, Canton Vaud, Switzerland, August 19

"Report of an Unusual Phenomenon Observed at Sea"

I CAN supply a second instance of the "unusual phenomenon observed at sea," communicated by the Hydrographer of the Navy to NATURE, vol. xxi. p. 291.

One night in April, 1875 (I cannot give the exact date, as my notes were lost in the ship) H.M.S. *Bulldog* was lying becalmed in a glassy sea off a point of land a few miles north of Vera Cruz, when a line of light appeared along the northern horizon, and unaccompanied by the least breath of wind, swept towards and past the ship, in a series of swift luminous pulsations, precisely similar to those described by Mr. Pringle. Acting on the old sea formula, "observed a phenomenon, caught a bucketful," we dipped up some of the water, and found noctilucæ and crustaceans in it. These may have supplied the luminosity, but if so, the exceedingly swift-travelling cause of their stimulation would still remain unaccounted for.

A squall accompanied by incessant thunder and lightning overtook the ship the same night.

EDWARD L. MOSS

Rathgar, Dublin, August 19

Boring Molluscs

THE following extract from Prof. Joseph Leidy's paper on "Vertebrate Remains, chiefly from the Phosphate Beds of South Carolina," which appeared in NATURE, vol. xx. p. 354, will serve in aid of the solution of the still open question, By what means do the boring molluscs penetrate hard rocks?—"The fossils mainly consist of the harder parts of the skeleton and of teeth, usually more or less water-worn, indicating shallow seas and an active surf to which they were exposed. Many of them exhibit the drilling effects of boring molluscs, especially those which are supposed to have been derived from the tertiary marl rock, the operation of drilling apparently having been performed both before and during the time the fossils were imbedded in the rock. Only enamel, or the enamel-like dentinal layer such as is found investing the crown of the teeth of sharks, appears to have been a protection against the drilling power of the borers."

Were the burrows produced by the solvent action of an acid, there is no reason why the enamel should have arrested the solvent rather than the dentine, although it might yield more slowly to it; but its refractory behaviour under friction accounts for the Pholades and Teredines being nonplused; while their desistance from fruitless efforts affords an instructive example of pure *instinctive* action, *i.e.*, reflex action "the prompting to which is given by sensations."

PAUL HENRY STOKOE

Beddington Park

Intellect in Brutes

A CORRESPONDENT of yours tells a tale (NATURE, vol. xx. p. 338) about a cat ringing a bell to be let in. Without any wish of "topping" this tale, I think the following will go far to demonstrate the existence of a thinking power in the brute brain, if indeed that fact is ever doubted:—

Some relatives of mine living in Sussex owned a very intelligent dog of somewhat doubtful breed, having, however, a decided touch of the French poodle in his composition. In addition to this animal they also had a favourite cat. For some time they were bothered in the way your correspondent describes by runaway knocks, instead of rings, as in his case; however, they discovered that the cat had learnt to stand on her hind legs and reach the knocker which was low on the door, and to knock distinct and separate double knocks until she was admitted. This in itself was curious, but a short time after they discovered this fact they discovered another still more curious. They were in the habit of turning the dog out every evening for an airing. It invariably happened that if the cat was out of the house at the same time, that a short time after the dog was turned out they would hear a knock at the door. On its being opened both animals would be found outside and would immediately come in, the dog always allowing the cat to precede him. There seems to be no doubt that the dog finding out that the cat could obtain entrance was in the habit of searching for her when he wanted to come in, and either waiting till she was ready to knock at the door, or of inducing her to do it to please him. I can myself vouch for the above facts.

W. H. KESTEVEN

Holloway, August 13

MR. LAYARD's letter mentioning the bell-ringing cat leads me to send the following account of a wise old Scotch collie with which I was personally acquainted. Toby, belonging to my friend Mr. T. F. Hancock, formerly of Tyes Place, Staplefield, Sussex, was passionately fond of his vocation, but at the same time made much of in the parlour. On one occasion, while lying in front of the fire in the dining-room, he heard sheep going by the house along the farm-road. He ran to the window-seat and then to the door, at the same time looking imploringly at my friend's sisters, as if to beg them to let him out. This, however, they declined to do, and after one or two journeys between window and door, he ran to the long, old-fashioned bell-pull, rang the bell, stood at the door, and bolted out and round into the kitchen as soon as the servant appeared.

After this Toby was constantly employed during meals to ring the bell, and I have myself often made him perform the operation, which was always accompanied by a good deal of barking. My friend has a more than life-sized painting of this wise dog, painted by the late Charles Hancock, the animal-painter.

One more instance of reasoning I will relate. A few months ago my wife and I were bathing a cocker dog in the stream flowing through the grounds of St. Helen's, Cockermouth. We threw a croquet-ball into deep water, and the dog was to bring it to shore. But the ball was rather large for the size of her mouth, and as often as she snapped at it the ball glided away. After vainly endeavouring to grip the ball, we watched her suddenly give over, and begin pawing it with her fore-feet until she brought it into shallow water, when she easily made the capture, and brought the ball to the bank. The same was repeated several times. It is unnecessary to say that this was not the result of teaching.

J. CLIFTON WARD

Keswick, August 14

As your pages have for some time drawn attention to such inquiries, I wish to ask if any one ever saw a favourite dog, or other animal, stop to gaze at a rainbow? We have never heard of such a case; but if ever encountered a record in your pages is invited.

BENJ. ALVORD

Washington, August 7

CONTENTS

THURSDAY, SEPTEMBER 4, 1879

THE HUMAN SPECIES

The Human Species. By A. de Quatrefages, Professor of Anthropology in the Museum of Natural History, Paris. (London: C. Kegan Paul and Co., 1879.)

THERE is possibly no science which is so generally misunderstood, and yet has had so many works of popular exposition, as anthropology. It is but a few years ago that the works of Latham, Lawrence, Pickering, and Prichard formed almost solely the consulting literature of the science in this country; and without referring to the various standard works that have since been contributed on special branches of the subject by English workers, the exclusively English reader has perhaps been enabled to consult the translated works of continental anthropologists to a greater extent than has been the opportunity of the student in other fields of science. During the last fifteen years volumes of Blumenbach, Broca, Gastaldi, Peschel, Pouchet, Topinard, Vogt, and Waitz have appeared in this country in our own language, and now to the list may be added the work of the distinguished naturalist under notice, whose name, however, will be popularly remembered as the author of "Rambles of a Naturalist on the Coasts of France, Spain, and Sicily," which appeared in London in 1857.

Naturally, among the above treatises, there are to be found wide divergences of views, and perhaps the student of anthropology should be above all others careful to avoid the scientific extremes of either a Paul or Barnabas persuasion. It is, however, absolutely necessary that we should understand our author, especially that we should learn whether he approaches the consideration of the study of man with any preconceived notions, which may be peculiar to himself or not generally held by other thinkers. This M. de Quatrefages promptly discloses in the first division of his book, entitled "Unity of the Human Species," a subject which seems still somewhat of a burning question among French anthropologists. The question as to there being a fundamental distinction between man and other animals is settled in the affirmative, and for the following reasons:—

1. Man has the *perception of moral good and evil*, independently of all physical welfare or suffering.

2. Man *believes in superior beings* who can exercise an influence upon his destiny.

3. Man *believes in the prolongation of his existence after this life.*

Readers of Lubbock, Spencer, or Tylor will perhaps scarcely accept this as the philosophy at least of primitive man, but, in justice to M. de Quatrefages, we must endeavour to obtain his definition of the moral and religious stage, and this again is clearly set forth in the following sentence:—"The learned mathematician, who seeks by the aid of the most profound abstractions the solution of some great problem, is completely without the moral or religious sphere into which, on the contrary, the ignorant, simple-minded man enters when he struggles, suffers, or dies for justice or for his faith."

In discussing the different colours of mankind, melanism is considered to be the result of accidental variations, and is compared with that which, appearing in our poultry-yards from time to time, is only prevented from spreading by the destruction of the fowls attacked. It is a question, however, whether the occurrence of melanism in our poultry-yards is not often an instance of atavism, and it is probably incorrect to say (p. 49) that the flesh of black fowls presents a repugant appearance, and for this reason the propagation of the variety is prevented, when, as is generally well known, fowls of the black Spanish breed are greatly valued as table birds. This section concludes with a discussion of the vexed term "species," and, according to M. de Quatrefages, *knowledge of facts* preceded *terminology*, and his arguments compel him to the opinion that "species is then a reality." Without, however, going so far as to say with Goethe that species exist only in the copybooks of the specialists, is it not certainly a fact that the founders of zoological nomenclature and classification based their conclusions then, much as we do, and necessarily in zoological descriptions of to-day, on the general outward resemblance and structure of living forms, and that knowledge of facts more frequently follows terminology, as any well qualified and exhaustive monograph of an animal group that has been long worked and studied by zoologists of different views and methods will exhibit? Few ornithologists, in describing a new fruit-pigeon from abroad, are guided by the researches of Darwin on the multitudinous variations of the domestic pigeon at home; and as for the descriptive entomologist, he, at least, can hardly realise species as a reality with his present limited knowledge of the life histories of exotic insects. In a philosophic sense the word species, as a rule in zoological literature, is a useful biological conventionalism, as necessary but as difficult to rigidly define as the term atom, and often playing as valuable a part in classification or generalisation as the "imaginary quantity" of the mathematician fulfils in the course of his calculations. It is for these reasons that we have found a difficulty in following M. de Quatrefages in all the rigidity of his specific definitions.

The second portion of the work is devoted to the "origin of the human species." To the question whether it is possible to explain the appearance on our globe of a being "which forms a kingdom to itself," M. de Quatrefages does "not hesitate to reply in the negative." It is to be noted how such an eminent naturalist as our author is still opposed to Darwinism, which in this section receives copious treatment, and some of the grounds principally given for its rejection are to many minds who embrace it the reasons of their faith. "The positive knowledge which has been won by nearly two centuries of work" is not considered by Darwinists to be invalidated, but rather illuminated, by the light of "natural selection," and facts which were unmeaning before, now by its aid form one harmonious whole in an evolutionary cosmos. It is remarkable that the doctrine of "natural selection" appears to have been a greater stumbling-block to the French mind than might naturally have been expected, whilst in German thought it seems to have at once supplied a want. Is it that French biology has never cared to depart from the glory that illumines the work of the illustrious Cuvier, and, like other schemes of philosophy, remains true but riveted to the teachings of its founder? Even M. de Quatrefages recognises something of this, and speaks of "the reserve, perhaps exaggerated, which Cuvier imposed upon himself, and the confidence which was placed in

him" as having weighed heavily upon science by impeding the comprehension of the value of new observations.

In discussing the antiquity of man, the present geological epoch is considered with "almost absolute certainty" as having commenced less than 100,000 years ago, and the opinion is pronounced that no facts have as yet been discovered which authorise us to place the cradle of the human race elsewhere than in Asia. As to the appearance of primitive man, our author concludes that "all that the present state of our knowledge allows us to say is that, according to all appearance, he ought to be characterised by a certain amount of prognathism, and have neither a black skin nor woolly hair. It is also fairly probable that his colour would resemble that of the yellow races, and his hair be more or less red. Finally, everything tends to the conclusion that the language of our earliest ancestors was a more or less pronounced monosyllabic one."

Once in possession of these views of our author, we can with the greater advantage read the excellent summaries and descriptions which form a large portion of the work relative to migration, acclimatisation, and "fossil races"; but perhaps the most interesting are those devoted to the "Psychological Characters of the Human Species." These tend to show in a new sense the brotherhood of man, so that if political economy could be called the "dismal science," anthropology should be considered as the most cheerful of its learned sisters. M. de Quatrefages combats some of the views of Sir John Lubbock as expressed in his "Origin of Civilisation" with great force, and has some very useful reflections on the danger of attributing all sense of honesty as absent in certain races on insufficent data. "Nothing is more common than to hear travellers accuse entire races of an incorrigible propensity for theft. The insular populations of the South Sea have, amongst others, been reproached with it. These people, it is indignantly affirmed, stole even the nails of the ships! But these nails were *iron*, and in these islands, which are devoid of metal, a little iron was, with good cause, regarded as a treasure. Now, I ask any of my readers, supposing a ship with *sheathing* and *bolts* of gold, and nails of diamonds and rubies were to sail into any European port, would its sheathing or its nails be safe?"

In conclusion, though many parts of this work show that to the author Darwin must have lived and written in vain, and some of the portions appear as anthropology little advanced from the time of Prichard, we cannot but still feel grateful that the general literature of this little-known, but most necessary of sciences, should have been enriched by a useful though not infallible book.

W. L. DISTANT

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Parthenogenesis in a Beetle

I DO not know whether any instances have been recorded of parthenogenesis in the coleoptera, nor does the interest of the case I am about to relate consist in the discovery of the operation of a not uncommon mode of insect reproduction in a new field, but rather in its altogether abnormal and fortuitous character in the species of beetle concerned, viz., *Gastrophysa raphani*. My own observations hitherto on this species have been uniformly to the effect that unimpregnated females lay always barren eggs, and that one intercourse with the male renders fruitful all eggs subsequently laid. I bred the female in question from the egg this year, and have kept her isolated since her exclusion as an imago. She has laid, up to the present, about twenty batches of eggs consisting of about thirty-four and fifty-one alternately in the batch. Of these, some fifteen batches have been observed; and only in one of these, No. 10, to wit, consisting of thirty-four eggs, and in one of these thirty-four only were any traces of development observed. This batch was laid between the 2nd and 4th of August. On the 5th I noticed in one an appearance which is usual about this time in fertilised eggs, which I have been accustomed to think about as the "embryonic scroll," and which, on reference to Huxley's "Anatomy of Invertebrated Animals," pp. 444–445, I am inclined to think may be what is there called "the *sternal band* (*Keimstreif* of the German embryologists)." This scroll is invariably present in gastrophysa eggs regularly developing, and enables one to predict with certainty the position of the ventral aspect, and of the head and tail of the future larva. On the 6th this same appearance was more distinctly marked. On August 10 a further well-defined stage of development had been reached. On the 11th the ocelli were plainly visible. Next day I noted the antennæ, mandibles, palpi, and legs. The segments, warts, and spiracles were also to be seen. On the 12th and some subsequent days I saw plainly somewhat feeble but unmistakable and decided movements of the legs, especially of the tarsi and ungues. At this season of the year the egg should have been hatched in about ten or twelve days. I have no longer any hope of this, and all larval movements appear to have ceased. All the other (thirty-three) eggs have undergone the usual degeneration, but this one presents a striking contrast to them, showing all the external parts perfectly formed and distinctly visible, as far as the position of the larva (which is just the reverse of the usual one, namely, with the dorsum in place of the venter next the surface of attachment) allows them to be seen. There is an unusual appearance of brownish coloration towards the caudal end, the nature of which I have not made out. The failure to hatch out, however, does not hinder this from being a decided case of embryonal development in an egg laid by a female of *Gastrophysa raphani* whose virginity is assured; and it is a solitary instance occurring among some eight or nine hundred eggs laid by the same beetle both before and after and along with it, all of which (as far as observed) were normally and uniformly barren.

J. A. OSBORNE

Milford, Letterkenny, August 18

Fonts in the Rocks of Brook Courses

I BELIEVE the present an opportune time to direct the attention of geologists to the occurrence of water-graven *fonts* in the rocks of brook courses, as the season of field-work is come, and the summer conditions of our water-courses facilitate observations of this most curious and interesting, as well as deeply important, of river physics.

So long ago as two years, examining the rocks bared on a river channel for the purpose of making a section, I found *fonts* in the rocks over which the waters run (in Slievardagh coal-field, Tipperary). I had not previously known of their occurrence. Those I first found I then looked on as something exceptional, but as my investigations extended and as I learned to recognise the conditions under which *fonts* are graven, I found them to be pretty general in streams having rapid descents. Nor do I think their occurrence is generally known and noted by geologists and physicists. I have seen in print but one allusion to them—in NATURE, vol. xix. p. 76, where they are notified as observed in a river in East Africa during the dry season as a "noteworthy peculiarity."

In what hereinafter appears, I do not at all mean to question the theory given as explanatory of the large "well-like basins" on the African river; doubtless our traveller had his good reasons for his conclusions.

The mode of occurrence of these fonts in the Slievardagh brooks is, I venture to submit, as follows:—They are graven in the rocks by falling waters; these waters being the main stream,

a portion (and it may be a diminutive quantity) locally detached from the main stream, or a feeder dropping into the main stream from steep, rocky sides. This is the primary cause. But along with the presence of a graving machine in the falling waters, to explain the making of the fonts a concurrent cause is necessary, as otherwise they should be looked for anywhere and everywhere on rapid descents. The conducive condition is the coincidence of falling waters with a *weakness* of the rock, such as an intersection of the division planes or fissures. I have secured a specimen font, 10 inches deep and 12 inches width across the bell-shaped mouth, in compact siliceous rock graven by a diminutive shoot of the main stream running down the depression which generally marks the edge of a division plane till it reached an intersection; at the intersection it graved a font, and issuing from this went on to the next, and there graved another (see sketch, Fig. 1). The stream, flowing round and kept up by a bed of rock dipping approximately in the direction of the current, overflows in flood-time, or generally except in dry summer weather, down the fissure A B; at the intersections the fonts were graven, and the water on leaving the lower one runs along the edge of a superposed bed. We are now bound to seek a limiting condition, as otherwise almost every pool into which there

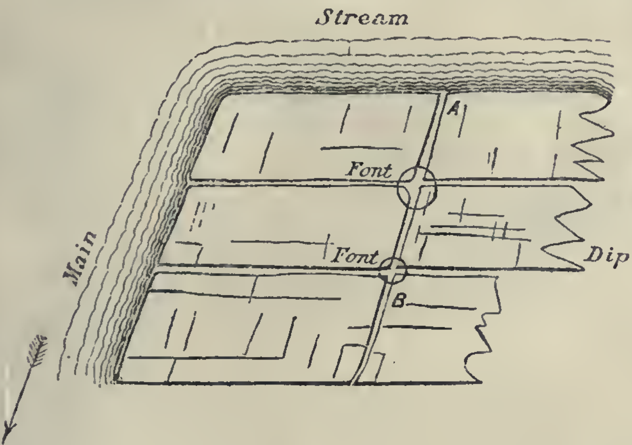


Fig. 1

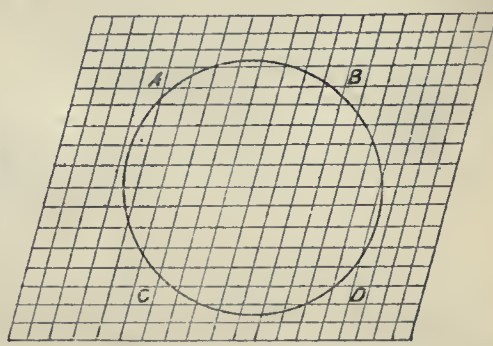


Fig 2

is a waterfall might reasonably be expected to be a font. The limiting cause is the relation between the size of the blocks into which the rock is divided and the graving power of the falling waters. If the waterfall is sufficient to grave a font of over a certain size in rocks broken by planes into blocks of a certain size, the consequence is that the whole blocks or blocks by fragments will be broken away, and the walls will be the divisional planes of the rock and lose altogether the font shape, as is wholly or partially the case under our larger waterfalls owing to the "pigmy plan" on which our (Slievardagh) rocks are broken up by planes. Fig. 2 will explain the meaning I wish to convey. Suppose the rocks broken by two sets of planes, and there may be many sets and the stratification as well; now suppose a font graven to the size of the circle; it is plain that this could not have stability, as the blocks at A, B, C, D would have come away during the process. But had the font been so small as to take only a portion of any four blocks no discontinuance of the graving action could yet have occurred.

I may add that about 2 feet in width and depth is the size of the largest font I have come upon hitherto.

WILLIAM MORRIS

Earlshill Colliery, Thurles

The Good Time Begun

THE following has just been received from a nephew in the Bombay Presidency, who, after speaking generally of a tremendous gale from the south-west, with heavy sea, fog, &c., all along the West Coast, writes thus more particularly:—

"That same mist and rain have been for the present the saving of this Presidency from another famine. It (the rain) has been general and heavy all over the country, and was just in time to save the crops, which were fast perishing from lack of moisture. If we have a little more this month and another good fall in September, we shall be quite safe; and I do trust we shall not be disappointed, as another year—the fourth in succession—of scarcity would well nigh make 'the bankruptcy of India,' so far as Bombay is concerned, a sad fact."

You will note the appearance of this desiderated Indian rain coming from the same direction as the chief part of that which has been deluging our own country; but which Mr. Campbell shrewdly attributed, in NATURE, vol. xx. p. 403, to the sun recovering his forces and beginning already to shine, after his recent languid, spotless years, with increased radiation on the great oceans of the south.

PIAZZI SMYTH

15, Royal Terrace, Edinburgh, August 30

Insect-Swarms

IN answer to Mr. Hawkshaw's question whether any one had seen a flight of moths and butterflies in England similar to the one he observed at Trouville on August 12 and 13, I can say that on August 12 I was walking on the Dawlish Warren (a bar of sand stretching across the mouth of the Exe) and noticed a great number of *P. gamma* moths; they were close to the edge of the water; many of them were dead, and the sand hoppers were eating them, but many more were alive and trying to flutter inland, but seemed too weak to do so. I picked up some and carried them to some wild thyme and they began to feed at once. Some of the moths were in good condition but others very much battered. The wind was blowing freshly from the sea at the time. The moths swarmed in the hedges all the way from our house to the Warren, a distance of four miles, especially on the bramble flowers. There were a great many *V. cardui* with the moths in the hedges, but none on the beach. A few days afterwards I had a letter from my brother at Dieppe saying there had been a swarm of moths and butterflies there, especially mentioning *P. gamma* and *V. cardui*, but there were also skippers and clouded whites. They swarmed about the town and country and were lying dead on the beach. The swarm of moths and butterflies was also on August 12.

EDITH PYCROFT

Kenton, near Exeter, August 31

Earthquake in Dominica

A SEVERE shock of earthquake was felt here at 1.20 A.M. yesterday (Sunday) the 10th instant, and at intervals, until 1.52, there were several tremulous movements of the earth. The noise immediately preceding the first shock reminded me of the clatter which is sometimes heard on board an ocean-going steamer in very rough weather, when a heavy sea strikes the ship, and all the crockery laid out for dinner is suddenly thrown from the "fiddles" and broken into pieces on the floor of the saloon.

After the first shock there was an interval of perfect quiet until 1.30, when subterranean noises like the discharging or booming of distant guns attracted my attention, and then, at

intervals varying from two to five minutes' duration, I counted six of these discharges, and following each discharge there came a gentle tremulous movement. Immediately after the last movement, heavy rain fell, and at 1.55 there were several flashes of very vivid lightning accompanied by loud peals of thunder. The rain continued to fall during all yesterday and last night.

Although Dominica is essentially of volcanic origin, and contains at the present day three active geysers, called respectively the Souffrière, the Walton Waven, and the Boiling Lake, no unusual quantity of sulphurous or mephitic vapours have lately been noticeable in the atmosphere; in fact, only one of the phenomena usually attending earthquakes preceded the shocks I have just described, and that was violent rain. The planters' "dry season" may be said to begin in January and to end in July, and during these months, harvesting, *i.e.*, sugar-making, goes on uninterruptedly. This year, however, there has been no "dry season," for 101·67 inches of rain have fallen on the east coast and 45·80 on the west coast of this island.

I may add, in conclusion, that being unwell and unable to sleep, I was reading by lamplight when the shocks above described took place, and that I timed them carefully with a chronometer-watch by Barraud and Lund, which was on a chair near my bed.

EDMUND WATT
Resident District Magistrate,
Leeward Islands

Dominica, British West Indies, August 11

Is it True that no Animal can be shown to have made Use of Antecedent Experience to intentionally improve upon the Past?

I HAD a pair of yellow African singing finches last year. The hen laid twenty-two eggs during the year, three at each nesting. In early spring I gave her materials to build with. She selected cotton wool and fine dryish grass for her purpose. It was very cold weather when she built her first nest in a little basket which I fixed high up in her cage.

The nest was a mere film of cotton wool lined with a few blades of grass. Of course the little creature could not sufficiently warm her eggs to hatch them, if they had proved fertile, which they did not.

At the end of fourteen days the cock, finding the eggs unhatched, set to work to bury them under cotton and grass (he being the only cock bird I had ever kept that built quite as well and as diligently as the hen did).

I then removed the eggs and the nest, and gave the birds fresh materials to build another nest with. They very soon accomplished this, making the nest of the same materials, *but thicker and more compact than the last.*

Again three white eggs were laid in it, but the hen could not get up the necessary degree of heat to hatch them, and at the end of fourteen days the cock set to work to build a third nest over them as before.

I again took away the nest and eggs, and I replaced the basket, this time covered externally with wadding and flannel, in hopes that thus I might help the hen to get up the proper temperature.

The little creatures immediately set to work to build again, but they this time built *a much thicker and warmer and more compact nest* than they had ever done before. The eggs proved fertile, and the process of incubation seemed to be successfully drawing to a close; but the patience of the cock did not suffice for the occasion. At the end of the tenth day he set to work to pull the cotton wool and grass about from the edges of the nest, and tried to bury the eggs as before, urging the hen to begin again also. This showed an unaccountable lack of instinct, not to say of reason; but surely the fact that the birds built each succeeding nest more and more thickly and warmly till incubation was possible indicates that they had made use of antecedent experience, and intentionally improved upon the past. These birds built a warm nest this spring, and succeeded in hatching a young one.

J. E. S.

Deltaic Growths

IN NATURE, vol. xix. p. 506, a Rangoon correspondent states that the Gulf of Martaban has shallowed 100 feet since the surveys of Captains Ross and Crawford, made probably thirty years ago. He is mistaken as to the date of these surveys for this reason:—

In 1822, at the outbreak of the first Burmese war, my father was appointed Flag Captain to Commodore Sir John Hayes's squadron, and he subsequently received the thanks of the Indian Government for, among other services, his surveys and explorations of the enemy's coasts and rivers. Now the soundings in the gulf would be about the first made. Hence the date would be 1822, or fifty-seven years ago. This shows an average annual deposit of 1·8 foot, which, although very much less than what Mr. Doyle imagines, is yet almost incredible. May there not have been a gradual rising of the sea bottom to assist?

FRASER S. CRAWFORD

Adelaide, South Australia, July 16

Sphinx (Deilephila) Lineata

As this insect is "unquestionably rare in England," and not common anywhere ("*D. Daucus*, a native of North America, being placed for it"—according to Mr. Stephens—"in collections"), perhaps I may be allowed to mention that a beautiful and perfect specimen of it was secured in my garden, on the 15th inst., by my little son, William Cecil. He was attracted to its resting-place in a wigelia bush by the flight there of a common gamma, and to his credit, inclosed it gently in his hand without the slightest injury—a prize indeed for a collector eight years old!

A specimen was also sent my daughter some months ago, from Porto Fino on the Riviera di Levante, by Mr. Robert Macdonald, but it was unfortunately wrecked in the post.

Bregner, Bournemouth, August 18 HENRY CECIL

The Recent Hail-storm

I INCLOSE a tracing of a broken window-pane—one of the the numerous cases of damage caused by the hail-storm on the morning of the 3rd inst. in this place. I almost fear the subject is one unworthy the attention of your readers, but I am curious to know what relation the space cut out may bear to the size of the hailstone causing it; and whether the clean and regular opening made would indicate an almost horizontal direction of the blow, as in the case of a bullet.

Observations of the extreme dimensions of the hailstones on that occasion are various among my neighbours, but one so large as 3½ inches seems incredible; and that one approaching such a size should strike a window at a right angle appears also improbable.

CHAS. FREDK. WHITE

42, Windsor Road, Ealing, August 20

OUR ASTRONOMICAL COLUMN

THE WASHINGTON CATALOGUE.—A second edition, as it is termed, of this extensive and useful work has been published, and will be found to be an even more important aid to the practical astronomer than the former one, which appeared as an appendix to the Washington volume for 1871, and to which reference has been made in this column as the "Washington General Catalogue." Like the first edition, it was prepared for publication by the late Prof. Yarnall, who died suddenly after a few hours' illness on February 27, having been an astronomer at the United States Naval Observatory for twenty-six years. In a note prefixed to this second edition, Admiral Rodgers, the present superintendent of the Observatory, handsomely acknowledges the extent and value of Prof. Yarnall's labours. A large majority of the observations upon which the catalogue is founded were made by him, as well as the computations, and the first printing of the work was executed under his immediate direction. It is stated that "the completed volume only reached him when he was already unconscious—an hour before his death. Astronomers will recognise in this volume not only a work of exceeding usefulness to them, but also a fitting memorial coming at the close of the long professional life of its author."

As was explained in the introduction to the former edition, the stars forming the catalogue consist mainly of stars used in observations with the zenith telescope, in the U.S. Army Surveys, in the lists of the Coast Survey, and many of Lacaille's stars mostly observed by Lacaille only. But there is a great addition of small stars, the

positions of which were required for the reduction of the observations made by the late Mr. James Ferguson during the years that he was so industriously and effectively observing with the equatorial. As a whole, therefore, the catalogue is a very miscellaneous one. The first edition contained 10,658 stars, with a number of cases, however, where the star had been observed only in one element, and included objects observed during the years 1845 to 1871. The new edition contains the results of observations to 1877, and includes 11,103 stars; the mean places are for the beginning of the year 1860, but it is to be borne in mind that they do not include any effect of proper motion from the mean date of observation, which is always given, to that general epoch. The annual precessions are annexed, without secular variation.

Like other publications of the U.S. National Observatory, the new Washington catalogue appears to have been most liberally circulated amongst astronomers.

NEW COMETS.—On August 21 a telescopic comet was discovered at Pola by Herr Palisa; its position at 10h. 26m. M.T. was in right ascension 150° 35′ and declination +49° 6′; daily motion in right ascension 1° 34′ increasing, and in declination 3 minutes diminishing; it was small but bright.

A second comet was discovered on August 24 at the Imperial Observatory, Strassburg, by Dr. Ernst Hartwig; it was then very faint and about $1\frac{1}{2}$ minutes in diameter. The following elements and ephemeris have been calculated by Dr. Hartwig, from the Strassburg observations on August 24 and 28, and one at Leipsic on August 26:—

Perihelion passage August 26·4661 M.T. at Berlin.

Longitude of perihelion	309° 56′·3	M.Eq. 1879·0.
,, ascending node ...	28 12·7	
Inclination	71 55·0	
Logarithm of perihelion distance	9·99056	

Motion—retrograde.

It will be found that these elements have no resemblance to those of any comet at present in our catalogues.

The following positions are for Berlin midnight:—

	Right Ascension. h. m. s.	Declination North. ° ′	Log. distance from Earth.	Sun.
Sept. 5	13 34 9	42 50·3	0·1055	9·9973
9	13 46 19	37 37·8	0·1314	0·0036
13	13 55 44	32 57·2	0·1577	0·0116
17	14 3 20	28 46·5	0·1834	0·0212
21	14 9 38	25 2·6	0·2081	0·0320
25	14 15 3	21 42·2	0·2315	0·0439
29	14 19 47	18 41·8	0·2535	0·0567

TO ASTRONOMERS

THE United States Naval Observatory will gratefully receive for its Library *separate copies* or *reprints* of memoirs published in the Transactions of learned societies or in journals. The volumes of Transactions are regularly received, but often many months after the reprints of particular papers, which are, therefore, especially valued.

It is also requested that all communications of this nature, and all correspondence relating to them, may be addressed to The Library, U.S. Naval Observatory, Washington, U.S.A.

Agents of the Smithsonian Institution abroad will receive large parcels for transmission. Smaller ones will be received more quickly if they are sent by post.

As far as possible the publications of the Observatory will be distributed to all working astronomers.

JOHN RODGERS,
Rear Admiral, U.S.N., Superintendent
Naval Observatory, Washington, D.C., August 18

GEOGRAPHICAL NOTES

THE Permanent Commission of the International Geodetic Association, presided over by General Ibañez, has decided to meet on the 16th inst. at Geneva, on the invitation which has been addressed to it by the Government of the little republic. The first official sitting is to be at 2 o'clock, on the 16th, at the Hotel de Ville of Geneva, in the room known as "the Alabama." In the evening Prof. E. Plantamour will hold a reception. The official sittings will continue daily at 10 A.M., in the same room, to the end of the week, interrupted on the 18th by a procession of steamers on the lake, which will occupy the whole of the day. On the evening of the 17th the Commissioners are invited to dine by the Council of the State of Geneva, and on the afternoon of the 19th there will be a reception at Sécheron by Prof. Plantamour. The programme of the session comprises: The reports of the Permanent Commission and the Central Bureau, the report of the Commission appointed at Hamburg in 1877 to consider the proposals of Lieut.-Col. Adan; the choice of the place of meeting of the sixth conference, and the appointment of special reporters to record the proceedings (1) As to determinations of latitude, longitude, and azimuth; (2) Triangulations and calculations of compensation of the networks; (3) Levelling operations and result of mareographic operations; (4) Measurements of the intensity of gravitation; (5) Publications relating to the measurement of degrees in Europe.

THE eminent African traveller, Dr. Junker, intends to start for Africa during this month. His first object is to reach Monbutta, which is to form the basis for his further investigations.

THE *Daily News* Lisbon correspondent telegraphs on September 2, that official news has arrived which states that on July 24 the explorers Ivens and Capello were in the district called Duque de Braganza. At the last session of the Geographical Society it was stated that the explorers were unable to continue their journey through want of means. The president promised to ask the Government to send them assitance. It will be remembered that Ivens and Capello started with Major Pinto.

WE find in the *Isvestia* of the Russian Geographical Society an interesting note by M. Potanin on the eastern Altai Mountains. Until 1869 these highlands were quite unknown, and even after the recent explorations of MM. Matusovsky and Sosnovsky it was considered that the Altai range did not go east of the meridian of Kobdo, where geographers, according to the map of Klaproth, supposed the existence of low hills which connected the Altai with the Tian Shan. Now M. Potanin proves that the Altai range goes further east, at least to the meridian of Lake Orok-nor, and that it is separated on its whole length by the Gobi steppe from the Tian Shan mountains. The altitude of the mountain passes in the parts visited by M. Potanin reaches as much as 8,000 feet. The eastern parts of the Altai mountains are rather dry, and forests in this part of the range are rather scarce.

THE same number of the *Isvestia* of the Russian Geographical Society contains an interesting note on the levelling accomplished during the last three years by the Russian General Staff on several lines of railways in Western Russia. The results are very satisfactory, as the probable error of this topographical levelling (with level and rule) does not exceed ± 2 inches on a distance of 100 versts (67 miles), *i.e.*, less than half the probable error of the best geodetical levellings. These levellings have brought to light a very interesting circumstance, namely, that the average level of the sea at Cronstadt is 13·2 ± 3·3 inches higher than at Dünamünde; the distance between the two towns being 240 miles. The Prussian levellings prove that the level of the Baltic is 20 inches higher at Kiel than at Memel.

CAPT. HOWGATE writes to us that he is preparing to send an expedition to the North Pole next year, independently of

the course to be taken by Congress next session. A ship fitted by him will start for Lady Franklin Bay, even if Congress leaves him unassisted.

NOTES

THE Central Meteorological Office of Italy (the Collegio Romano) has just issued the third part of a most useful series, forming one volume of 282 pp., imperial 8vo. (Imprimerie Héritiers Botta, Rome, 1879), which will be of great service to meteorologists generally. They contain a translation, in French, of all the Reports (*in extenso* or abridged) prepared upon the different questions comprised in the Programme of the Second International Meteorological Congress held at Rome in April of this year, together with many other papers communicated to the Congress. The work has been undertaken with the view of presenting to meteorologists, not only the whole of the questions which have been discussed by the Congress, but also the *ensemble* of the experiments and documents which have formed, so to speak, the basis of each discussion, and which represent, at the same time, the opinion ot the distinguished men from the whole of Europe upon the most important points of international meteorology. The translation has been carried out under the able superintendence of Prof. Guido Gras i, director of the Roman Central Office, and we congratulate that office upon the careful translation of the reports from the various languages and upon their speedy issue in one convenient volume.

OUR readers will be pleased to learn that Prof. Huxley's Introductory Primer to Macmillan's series of Science Primers will probably be published during the autumn; a considerable portion of it is already in type.

THE inauguration of Arago's statue will have the *éclat* of a national *fête*. The Municipal Council of Paris, of which Arago was an active member during Louis Philippe's reign, will send a deputation. The Bureau des Longitudes, the Observatory of Paris, and the Academy of Sciences, institutions which for years owed their lustre to the great Arago, are sending special representatives delegated for the purpose. M. Etienne Arago, the younger brother of the departed astronomer, a dramatic author, and M. Emmanuel Arago, his son, an influential member of the Senate, will be present at the ceremony, and will deliver addresses.

As will be seen from our British Association Reports, the Zoological Station at Naples has undertaken the publication of a new Zoological Record, in which equal attention will be paid to all departments of zoology. A large staff of zoologists of various nationalities will act as recorders, under the editorship of Prof. J. V. Carus, of Leipzig; and the first volume, dealing with the literature of the current year will appear in 1880. All those engaged in zoological work on any group of the animal kingdom are invited to send a copy of their papers to Prof. J. V. Carus, Leipzig, Querstrasse, 30; and to write on the address "for the Jahresbericht." Papers so sent will be distributed by Prof. Carus amongst the recorders, and after being abstracted for the Record, will be deposited in the library of the Zoological Station at Naples.

THE St. Petersburg Society of Naturalists has undertaken the publication of a complete Ornithology of Northern Russia. All who possess any data on that subject, or collections of birds, are requested to communicate them to "the St. Petersburg Society of Naturalists, at the University of St. Petersburg."

M. DOKUCHAIEFF, who was sent by the St. Petersburg Society of Naturalists for the exploration of the river and lacustrine quaternary deposits on the banks of the Oka, has discovered at the confluence of this river with the Frubesh, an immense quantity of stone implements. The dunes on the banks of the Oka in the neighbourhood of Kasimov town have also yielded a good many remains of prehistoric man. But the spot richest in remains is undoubtedly that five miles distant from Moorom town, where M. Dokuchaieff has found a remarkable variety of stone arrows, knives, and needles. As to the pieces, of wood which are very common in the blue clays of fluviolacustrine origin, and which were considered as remains of lacustrine dwellings, these are simply remains of forests which formerly covered all these deposits.

MR. CROOKES' admirable set of instruments for exhibiting the properties of radiant matter will be lectured upon at the Sorbonne at the beginning of next October, at the inauguration of the Autumn term of the Academy of Sciences.

ON October 6 next, a new Polytechnic Institution will be inaugurated at Hanover. The new building has recently been completed, and no cost has been spared to render it worthy to rank amongst the most complete and extensive buildings of the kind. Deputations from all the other polytechnic high school of Germany will participate in the inauguration-festivities.

THE death is announced of Dr. Otto Funke, Professor of Physiology at the University of Freiburg im Breisgau (Baden). Dr. Funke was an eminent physiologist, and lived at Leipzig for many years previous to his call to Freiburg. He died on August 16, at the age of fify-one years.

THE Congress of German Viticulturists is now meeting at Coblenz, and is discussing a number of viticultural questions of importance, including, of course, the much-ventilated phylloxera question. At the same place a meeting of Rhenish agriculturists will take place between September 7 and 10, accompanied by an agricultural exhibition.

THE Zoological Section of the Westphalian Provincial Society for Arts and Sciences had an interesting exhibition at the Zoological Gardens of Münster from August 17 to August 24 last. It consisted exclusively of invertebrate animals, illustrations of their habits and specimens of their products. The exhibition comprised insects (bees, beetles, butterflies, flies, grasshoppers, &c.), centipedes, spiders, crustaceans, annelids, molluscs (cephalopoda, gasteropoda, conchifera), echinoderms (holothuriæ, echinoidea, asteroidea), cœlenterata (medusæ), polyps, sponges, and infusoria. Most of the animals were represented in living as well as preserved specimens.

DURING the second week in August the German Anthropological Society met at Strasburg, under the presidency of Prof. Fraas. 164 members were present. Amongst the numerous interesting papers read we notice the following:—On the prehistoric map of Southern Germany and Eastern France, by Herr von Troeltsch; Professors Oehlenschlaeger (Munich) and Wagner (Karlsruhe) spoke on the same subject; Prof. Schaaffhausen (Bonn) lectured on skull measurements; Dr. Much (Vienna), on prehistoric traces of copper-mining; Prof. Klopfleisch (Jena), on his own excavations in Thuringia; a specially interesting papers was that by Herr Fischer (Freiburg), on the method of determining the age of stone weapons and utensils. Other papers were read by Dr. Gross (Naefels), on the pile-dwellings in the Biel Lake; Dr. Krause (Hamburg), on artificial alterations of the skulls of the natives of the New Hebrides; Dr. Mehlis (Tückheim), on the excavations at Limburg; Dr. Hook, on the stone age in Egypt. The next meeting of the Society will take place at Berlin, under the presidency of Prof. Virchow.

THE International Society for the prevention of the pollution of rivers, the soil, and the atmosphere, will hold its third meeting at Baden-Baden on the 16th and 17th inst.

AT Rome a new Society for furthering the introduction of cremation was formed on August 12 last. Many eminent medical men are members.

NEWS from the village of Havnen, Iceland, states that a violent volcanic eruption was observed at the end of May in the vicinity of the so-called Geisfugle shears, in the south-west of the island. It is curious that about the same time the eruption of Mount Etna took place.

THE first volume of a remarkable botanical work entitled "Versuch einer Entwickelungsgeschichte der Pflanzenwelt, insbesondere der Florengebiete seit der Tertiärperiode," by Dr. Ad. Engler, of Kiel, will be published next month by W. Engelmann, of Leipzig.

THE Rev. S. J. Whitmee informs us that he has received letters from the Society Islands assuring him there was no such devastation of the islands of Raiatea and Borabora (Porapora) by earthquake as was reported by Capt. Evers, and which is mentioned in the article "On Volcanic Phenomena during 1878," in NATURE, vol. xx. p. 378. No reference, he reminds us, is made in the article to the pumice and torn-up trees, carried apparently from the island of Birara, south-east to and beyond the Ellia Atolls, which he reported to us some months ago.

A CORRESPONDENT informs us that the observer of the Scottish Meteorological Society in Ireland reports fine weather there in June and July, with little or no rain, by which the pastures have suffered severely; but the fishing at most places is good, in direct contrast to what has prevailed in the British Isles.

THE City and Guilds Institute having granted 400*l.* per annum for purposes of technical education at University College, London, have resolved that the grant be appropriated in maintaining the chair of Chemical Technology, and that of Engineering and Mechanical Technology. The Professor of Chemical Technology, Dr. Charles Graham, has announced "Technical Education" as the subject of his public lecture at the College on October 1.

AN experiment before the Parisian press was tried on August 28, in the large room of the St. Lazare Railway Station, by a company started for establishing a Central Hall of Telephony under the Edison patent. The experiments were found quite satisfactory for musical instruments, but not so for the ordinary voice. The Company has received from the Government authority to inaugurate its operations, and a sum of 2*l.* per month is required for the use of a wire with the right of interchanging communications with any person having a wire directed to the Central Hall.

A SPECIAL excursion tour for members of the French Parliament has been organised to Algiers. The members will start in this month, and devote their vacation to the study of the land on behalf of which they are to legislate. The Municipal Council of Algiers has voted a sum of 200*l.* for the reception of their legislators.

WE take the following statements from a preliminary communication made to the Vienna Academy of Sciences by Herr G. L. Ciamician, with reference to the further results of his spectroscopic investigations:—"If the spectra of the metals of the alkaline earths are produced by the spark of an induction apparatus (with inserted Leyden jar) passing between the metals as electrodes in a hydrogen tube, then spectra are obtained which show the homology of the spectral lines in a most beautiful manner. The spectrum of magnesium, however, cannot be compared to the spectra thus obtained because it does not contain the less refrangible lines. If, however, the Leyden jar be removed, or if a weaker battery and a smaller induction coil be employed, all red and yellow lines in the spectra of calcium and strontium will disappear and spectra are obtained which are extremely similar to that of magnesium. If the less refrangible part of the spectrum of the group of alkaline earth-metals, which therefore is only visible at a high temperature (corresponding to a high electric tension), be compared to the less refrangible half of the complete oxygen spectrum, the remarkable similarity of these two spectrum-halves will at once strike the observer. The inference to be drawn from these facts would seem to be that the spectrum of the group of alkaline earth-metals is composed of the magnesium spectrum and of the less refrangible half of the oxygen spectrum.

A NUMBER of interesting observations made during a recent cruise of the French frigate *La Magicienne*, to various parts of the Pacific, chiefly formed the subject of a recent paper by Admiral Serres to the French Academy. Among other points attention had been drawn while at San Francisco to the swift tall-masted clipper ships which convey wheat to the European market. The modern practice of increasing the high sails at the expense of the lower is justified by science. During the voyage of *La Magicienne*, a Robinson anemometer was observed daily at an altitude of 8 metres, and twice every day the same instrument was observed at 36 metres. With very rare exceptions the velocity of the wind was always found much greater in the latter case than in the former. The average ratio deduced from thousands of observations was about 12 to 10. One can thus see the reason of seeking motive force in the upper regions.

PURSUING his researches on the scintillation of stars, M. Montigny shows, in a recent note to the Belgian Academy, that the following conclusion may be formulated:—When, in those observations where the colours characterising the phenomenon are distinctly separated, the blue tint predominates or is found in excess, rain may be expected, if it have not already come. There is great probability that the rain will be the more persistent and plentiful the more marked the predominance of blue. M. Montigny recalls the observations of P. Secchi, M. Janssen, and Prof. Piazzi Smyth, according to which the telluric lines of the solar spectrum increase in number and intensity in circumstances where the solar rays encounter a larger quantity of aqueous vapour in the atmosphere, either as the sun nears the horizon, or as the humidity of the air increases. Prof. Smyth bases predictions of rain on certain telluric bands in the spectrum, which he calls *rain-bands*. M. Montigny thinks there is no doubt that similar phenomena of absorption are produced in the case of certain rays emanating from the stars, where these traverse more or less moist layers of our atmosphere.

AN apparatus called the "telephone syren" has been recently described to the Schleswig-Holstein Society of Natural Sciences by Herr Karsten. On a circular disk 10 ctm. in diameter are fixed radially twenty-four small magnetic bars. This disk is rapidly rotated before a Bell telephone deprived of the iron plate. Where the same poles of the magnets are all directed outwards, one hears a certain tone; if the poles alternate, the lower octave is heard. If the succession of poles at the border of the disk be (say) N N S, there are heard three tones: one corresponding to the interval N N, one an octave lower corresponding to N S N, and a third combination-tone of three times the time of vibration of the highest, corresponding to the return, each time, of the first N. The vibration-numbers are thus as 3 : 2 : 1. Similar experiments may be made with the combination N N N S, where tones are obtained with the relation 4 : 2 : 1.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. W. T. Millar; a Rose Hill Parrakeet (*Platycercus eximius*) from New South Wales, presented by Mr. Arthur Stirling; a Common Kestrel (*Tinnunculus alaudarius*), British, presented by Mr. R. Moon; a Chequered Elaps (*Elaps lemniscatus*) from South America, presented by Dr. A. Stradling; an Annulated Snake (*Leptodira annulata*) from Colon, presented by Mr. R. F. Davis; three Horned Lizards

(*Phrynosoma cornutum*) from Texas, presented by Mr. Ernest E. Sabel; a Sulphur-breasted Toucan (*Ramphastos carinatus*) three Black-necked Stilt Plovers (*Himantopus nigricollis*), two Cayenne Lapwings (*Vanellus cayennensis*) from South America, a Slow Loris (*Nycticebus tardigradus*) from Malacca, a Radiated Tortoise (*Testudo radiata*) from Madagascar, two Electric Silurus (*Malapterurus beninensis*) from West Africa, purchased; a Squirrel-like Phalanger (*Belideus sciurea*), born in the Gardens.

ON RADIANT MATTER [1]

II.

Radiant Matter exerts strong Mechanical Action where it Strikes

WE have seen, from the sharpness of the molecular shadows, that radiant matter is arrested by solid matter placed in its path.

FIG. 10.

If this solid body is easily moved the impact of the molecules will reveal itself in strong mechanical action. Mr. Gimingham has constructed for me an ingenious piece of apparatus which when placed in the electric lantern will render this mechanical action visible to all present. It consists of a highly-exhausted glass tube (Fig. 11), having a little glass railway running along it from one end to the other. The axle of a small wheel revolves on the rails, the spokes of the wheel carrying wide mica paddles. At each end of the tube, and rather above the centre, is an aluminium pole, so that whichever pole is made negative the stream of radiant matter darts from it along the tube, and striking the upper vanes of the little paddle-wheel, causes it to turn round and travel along the railway. By reversing the poles I can arrest the wheel and send it the reverse way, and if I gently incline the tube the force of impact is observed to be sufficient even to drive the wheel up-hill.

This experiment therefore shows that the molecular stream

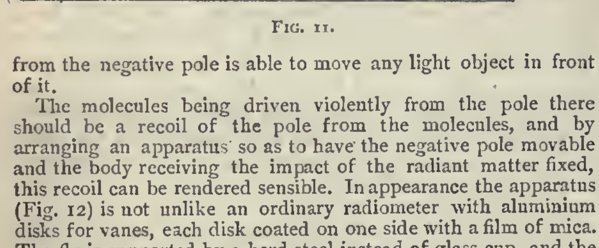


FIG. 11.

from the negative pole is able to move any light object in front of it.

The molecules being driven violently from the pole there should be a recoil of the pole from the molecules, and by arranging an apparatus so as to have the negative pole movable and the body receiving the impact of the radiant matter fixed, this recoil can be rendered sensible. In appearance the apparatus (Fig. 12) is not unlike an ordinary radiometer with aluminium disks for vanes, each disk coated on one side with a film of mica. The fly is supported by a hard steel instead of glass cup, and the needle-point on which it works is connected by means of a wire with a platinum terminal sealed into the glass. At the top of the radiometer bulb a second terminal is sealed in. The radiometer therefore can be connected with an induction-coil, the movable fly being made the negative pole.

For these mechanical effects the exhaustion need not be so high as when phosphorescence is produced. The best pressure for this electrical radiometer is a little beyond that at which the dark space round the negative pole extends to the sides of the glass bulb. When the pressure is only a few millims. of mercury, on passing the induction current a halo of velvety violet light forms on the metallic side of the vanes, the mica side remaining dark. As the pressure diminishes, a dark space is seen to separate the violet halo from the metal. At a pressure of half a millim. this dark space extends to the glass, and rotation commences. On continuing the exhaustion the dark space further widens out and appears to flatten itself against the glass, when the rotation becomes very rapid.

Here is another piece of apparatus (Fig. 13) which illustrates

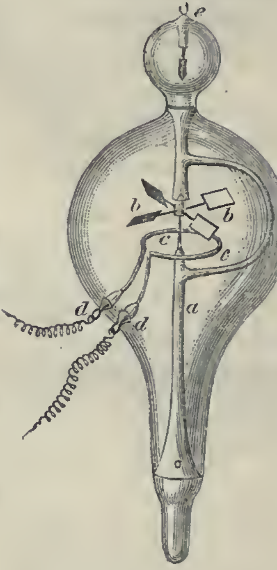


FIG. 12.

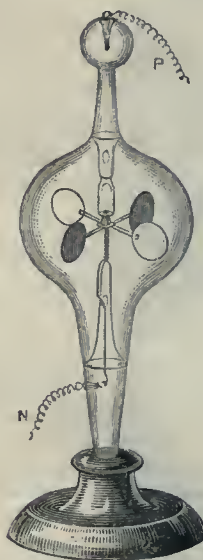


FIG. 13.

the mechanical force of the radiant matter from the negative pole. A stem (*a*) carries a needle-point in which revolves a light mica fly (*b b*). The fly consists of four square vanes of thin clear mica, supported on light aluminium arms, and in the centre is a small glass cap which rests on the needle-point. The vanes are inclined at an angle of 45° to the horizontal plane. Below the fly is a ring of fine platinum wire (*c c*), the ends of which pass through the glass at *d d*. An aluminium terminal (*e*) is sealed in at the top of the tube, and the whole is exhausted to a very high point.

By means of the electric lantern I project an image of the vanes on the screen. Wires from the induction-coil are attached,

FIG. 14.

so that the platinum ring is made the negative pole, the aluminium wire (*e*) being positive. Instantly, owing to the projection of radiant matter from the platinum ring, the vanes rotate with extreme velocity. Thus far the apparatus has shown nothing more than the previous experiments have prepared us to expect; but observe what now happens. I disconnect the induction-coil altogether, and connect the two ends of the platinum wire with a small galvanic battery; this makes the ring *c c* red-hot, and under this influence you see that the vanes spin as fast as they did when the induction-coil was at work.

Here, then, is another most important fact. Radiant matter in these high vacua is not only excited by the negative pole of an induction-coil, but a hot wire will set it in motion with force sufficient to drive round the sloping vanes.

[1] A lecture delivered to the British Association for the Advancement of Science, at Sheffield, Friday, August 22, 1879, by William Crookes, F.R.S. Continued from p. 423.

Radiant Matter is deflected by a Magnet

I now pass to another property of radiant matter. This long glass tube (Fig. 14), is very highly exhausted; it has a negative pole at one end (*a*) and a long phosphorescent screen (*b, c*) down the centre of the tube. In front of the negative pole is a plate of mica (*b, d*) with a hole (*e*) in it, and the result is, when I turn on the current, a line of phosphorescent light (*e, f*) is projected along the whole length of the tube. I now place beneath the tube a powerful horse-shoe magnet: observe how the line of light (*e, g*) becomes curved under the magnetic influence waving about like a flexible wand as I move the magnet to and fro.

This action of the magnet is very curious, and if carefully followed up will elucidate other properties of radiant matter. Here (Fig. 15) is an exactly similar tube, but having at one end a small potash tube, which if heated will slightly injure the vacuum. I turn on the induction current, and you see the ray of radiant matter tracing its trajectory in a curved line along the screen, under the influence of the horse-shoe magnet beneath. Observe the shape of the curve. The molecules shot from the negative pole may be likened to a discharge of iron bullets from a mitrailleuse, and the magnet beneath will represent the earth curving the trajectory of the shot by gravitation. Here on this luminous screen you see the curved trajectory of the shot accurately traced. Now suppose the deflecting force to remain constant, the curve traced by the projectile varies with the velocity. If I put more powder in the gun the velocity will be greater and the trajectory flatter, and if I interpose a denser resisting medium between the gun and the target, I diminish the velocity of the shot, and thereby cause it to move in a greater curve and come to the ground sooner. I cannot well increase before you the velocity of my stream of radiant molecules by putting more

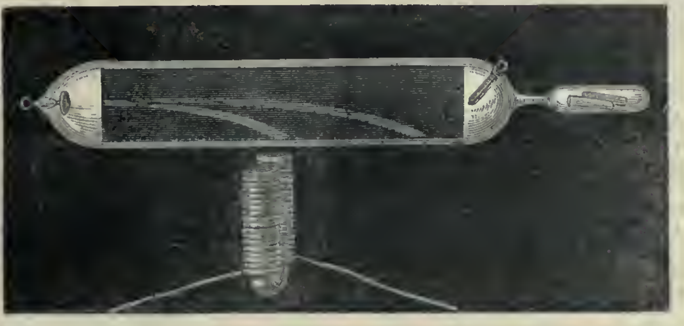


FIG. 15.

powder in my battery, but I will try and make them suffer greater resistance in their flight from one end of the tube to the other. I heat the caustic potash with a spirit-lamp and so throw in a trace more gas. Instantly the stream of radiant matter responds. Its velocity is impeded, the magnetism has longer time on which to act on the individual molecules, the trajectory gets more and more curved, until, instead of shooting nearly to the end of the tube, my molecular bullets fall to the bottom before they have got more than half-way.

It is of great interest to ascertain whether the law governing the magnetic deflection of the trajectory of radiant matter is the same as has been found to hold good at a lower vacuum. The experiments I have just shown you were with a very high vacuum. Here is a tube with a low vacuum (Fig. 16). When I turn on the induction spark, it passes as a narrow line of violet light

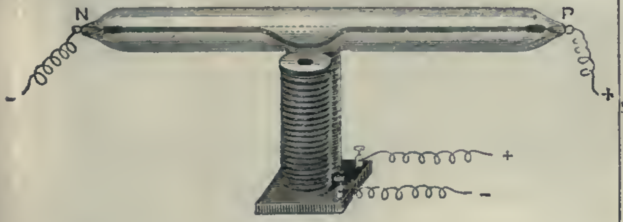


FIG. 16.

joining the two poles. Underneath I have a powerful electromagnet. I make contact with the magnet, and the line of light dips in the centre towards the magnet. I reverse the poles, and the line is driven up to the top of the tube. Notice the difference between the two phenomena. Here the action is temporary. The dip takes place under the magnetic influence; the line of discharge then rises and pursues its path to the positive pole. In the high exhaustion, however, after the stream of radiant matter had dipped to the magnet, it did not recover itself, but continued its path in the altered direction.

By means of this little wheel, skilfully constructed by Mr. Gimingham, I am able to show the magnetic deflection in the electric lantern. The apparatus is shown in this diagram (Fig. 17). The negative pole (*a, b*) is in the form of a very shallow cup. In front of the cup is a mica screen (*c, d*), wide enough to intercept the radiant matter coming from the negative pole. Behind this screen is a mica wheel (*e, f*) with a series of vanes, making a sort of paddle-wheel. So arranged, the molecular rays from the pole *a b* will be cut off from the wheel, and will not produce any movement. I now put a magnet, *g*, over the tube, so as to deflect the stream over or under the obstacle *c, d*, and the result will be rapid motion in one or the other direction, according to the way the magnet is turned. I throw the image of the apparatus on the screen. The spiral lines painted on the wheel show which way it turns. I arrange the magnet to draw the molecular stream so as to beat against the upper vanes, and the wheel revolves rapidly as if it were an overshot water-wheel. I turn the magnet so as to drive the radiant

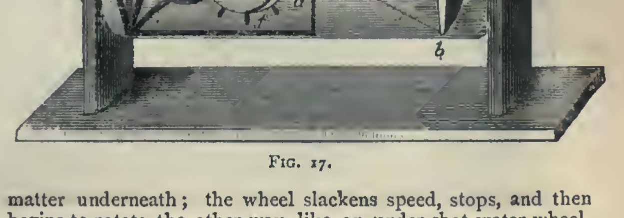


FIG. 17.

matter underneath; the wheel slackens speed, stops, and then begins to rotate the other way, like an under-shot water-wheel. This can be repeated as often as I reverse the position of the magnet.

I have mentioned that the molecules of the radiant matter discharged from the negative pole are negatively electrified. It is probable that their velocity is owing to the mutual repulsion between the similarly electrified pole and the molecules. In less high vacua, such as you saw a few minutes ago (Fig. 16), the discharge passes from one pole to another, carrying an electric current, as if it were a flexible wire. Now it is of great interest

to ascertain if the stream of radiant matter from the negative pole also carries a current. Here (Fig. 18) is an apparatus which will decide the question at once. The tube contains two negative terminals (*a*, *b*) close together at one end, and one positive terminal (*c*) at the other. This enables me to send two streams of radiant matter side by side along the phosphorescent screen—or by disconnecting one negative pole, only one stream.

If the streams of radiant matter carry an electric current they will act like two parallel conducting wires and attract one

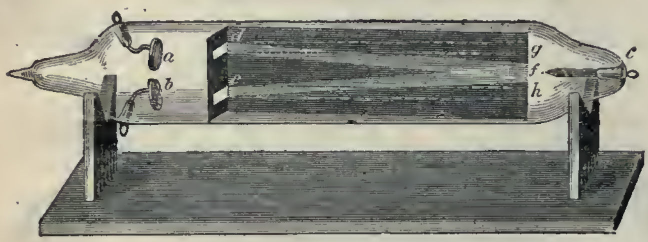


Fig. 18.

another; but if they are simply built up of negatively electrified molecules they will repel each other.

I will first connect the upper negative pole (*a*) with the coil, and you see the ray shooting along the line *d*, *f*. I now bring the lower negative pole (*b*) into play, and another line (*e*, *h*) darts along the screen. But notice the way the first line behaves; it jumps up from its first position, *d f*, to *d g*, showing that it is repelled, and if time permitted I could show you that the lower ray is also deflected from its normal direction: therefore the two parallel streams of radiant matter exert mutual repulsion, acting not like current carriers, but merely as similarly electrified bodies.

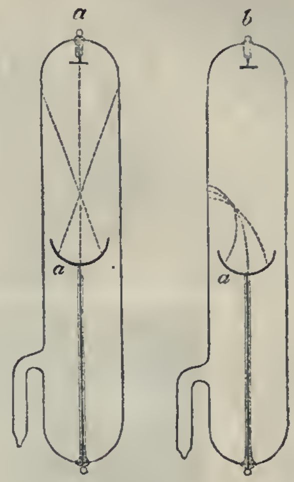


Fig. 19.

Radiant Matter produces Heat when its Motion is arrested

During these experiments another property of radiant matter has made itself evident, although I have not yet drawn attention

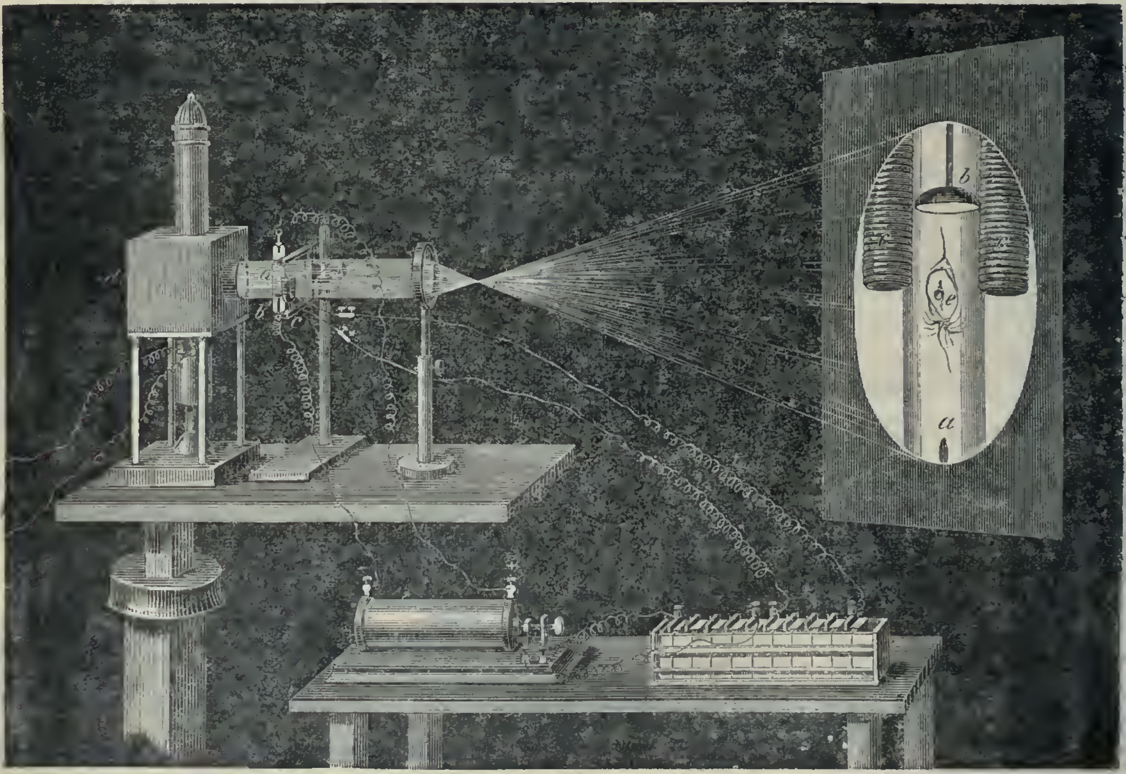


Fig. 20.

to it. The glass gets very warm where the green phosphorescence is strongest. The molecular focus on the tube, which we saw earlier in the evening (Fig. 8) is intensely hot, and I have prepared an apparatus by which this heat at the focus can be rendered apparent to all present.

I have here a small tube (Fig. 19, *a*) with a cup-shaped negative pole. This cup projects the rays to a focus in the middle of the tube. At the side of the tube is a small electro-magnet, which I can set in action by touching a key, and the focus is then drawn to the side of the glass tube (Fig. 19, *b*). To show the first action of the heat I have coated the tube with wax. I will put the apparatus in front of the electric lantern (Fig. 20, *d*), and throw a magnified image of the tube on the screen. The coil is now at work, and the focus of molecular

rays is projected along the tube. I turn the magnetism on, and draw the focus to the side of the glass. The first thing you see is a small circular patch melted in the coating of wax. The glass soon begins to disintegrate, and cracks are shooting star-wise from the centre of heat. The glass is softening. Now the atmospheric pressure forces it in, and now it melts. A hole (*e*) is perforated in the middle, the air rushes in, and the experiment is at an end.

I can render this focal heat more evident if I allow it to play on a piece of metal. The bulb (Fig. 21) is furnished with a negative pole in the form of a cup (*a*). The rays will therefore be projected to a focus on a piece of iridio-platinum (*b*) supported in the centre of the bulb.

I first turn on the induction-coil slightly, so as not to bring out its full power. The focus is now playing on the metal, raising it to a white heat. I bring a small magnet near, and you see I can deflect the focus of heat just as I did the luminous focus in the other tube. By shifting the magnet I can drive the focus up and down, or draw it completely away from the metal, and leave it non-luminous. I withdraw the magnet, and let the molecules have full play again; the metal is now white hot. I increase

Fig. 21.

the intensity of the spark. The iridio-platinum glows with almost insupportable brilliancy, and at last melts.

The Chemistry of Radiant Matter

As might be expected, the chemical distinctions between one kind of radiant matter and another at these high exhaustions are difficult to recognise. The physical properties I have been elucidating seem to be common to all matter at this low density. Whether the gas originally under experiment be hydrogen, carbonic acid, or atmospheric air, the phenomena of phosphorescence, shadows, magnetic deflection, &c., are identical, only they commence at different pressures. Other facts, however, show that at this low density the molecules retain their chemical characteristics. Thus by introducing into the tubes appropriate absorbents of residual gas, I can see that chemical attraction goes on long after the attenuation has reached the best stage for showing the phenomena now under illustration, and I am able by this means to carry the exhaustion to much higher degrees that I can get by mere pumping. Working with aqueous vapour I can use phosphoric anhydride as an absorbent; with carbonic acid, potash; with hydrogen, palladium; and with oxygen, carbon, and then potash. The highest vacuum I have yet succeeded in obtaining has been the 1-20,000,000th of an atmosphere, a degree which may be better understood if I say that it corresponds to about the hundredth of an inch in a barometric column three miles high.

It may be objected that it is hardly consistent to attach primary importance to the presence of *Matter*, when I have taken extraordinary pains to remove as much matter as possible from these bulbs and these tubes, and have succeeded so far as to leave only about the one-millionth of an atmosphere in them. At its ordinary pressure the atmosphere is not very dense, and its recognition as a constituent of the world of matter is quite a modern notion. It would seem that when divided by a million, so little matter will necessarily be left that we may justifiably neglect the trifling residue and apply the term *vacuum* to space from which the air has been so nearly removed. To do so, however, would be a great error, attributable to our limited faculties being unable to grasp high numbers. It is generally taken for granted that when a number is divided by a million the quotient must necessarily be small, whereas it may happen that the original number is so large that its division by a million seems to make little impression on it. According to the best authorities, a bulb of the size of the one before you (13·5 centimetres in diameter) contains more than 1,000,000,000,000,000,000,000,000 (a quadrillion) molecules. Now, when exhausted to a millionth of an atmosphere we shall still have a trillion molecules left in the bulb—a number quite sufficient to justify me in speaking of the residue as *matter*.

To suggest some idea of this vast number I take the exhausted bulb, and perforate it by a spark from the induction-coil. The spark produces a hole of microscopical fineness, yet sufficient to allow molecules to penetrate and to destroy the vacuum. The inrush of air impinges against the vanes, and sets them rotating after the manner of a windmill. Let us suppose the molecules to be of such a size that at every second of time a hundred millions could enter. How long, think you, would it take for this small vessel to get full of air? An hour? A day? A year? A century? Nay, almost an eternity! A time so enormous that imagination itself cannot grasp the reality. Supposing this exhausted glass bulb, indued with indestructibility, had been pierced at the birth of the solar system; supposing it to have been present when the earth was without form and void; supposing it to have borne witness to all the stupendous changes evolved during the full cycles of geologic time, to have seen the first living creature appear, and the last man disappear; supposing it to survive until the fulfilment of the mathematician's prediction that the sun, the source of energy, four million centuries from its formation, will ultimately become a burnt-out cinder;[1] supposing all this—at the rate of filling I have just described, 100 million molecules a second—this little bulb even then would scarcely have admitted its full quadrillion of molecules.[2]

But what will you say if I tell you that all these molecules, this quadrillion of molecules, will enter through the microscopic hole before you leave this room? The hole being unaltered in size, the number of molecules undiminished, this apparent paradox can only be explained by again supposing the size of the molecules to be diminished almost infinitely—so that instead of entering at the rate of 100 millions every second, they troop in at a rate of something like 300 trillions a second. I have done the sum, but figures when they mount so high cease to have any meaning, and such calculations are as futile as trying to count the drops in the ocean.

In studying this fourth state of matter we seem at length to have within our grasp and obedient to our control the little indivisible particles which with good warrant are supposed to constitute the physical basis of the universe. We have seen that in some of its properties radiant matter is as material as this table, whilst in other properties it almost assumes the character of radiant energy. We have actually touched the borderland where matter and force seem to merge into one another, the shadowy realm between Known and Unknown which for me has always

[1] The possible duration of the sun from formation to extinction has been variously estimated by different authorities, at from 18 million years to 400 million years. For the purpose of this illustration I have taken the highest estimate.

[2] According to Mr. Johnstone Stoney (*Phil. Mag.*, vol. 36, p. 141), 1 c.c. of air contains about 1,000,000,000,000,000,000,000 molecules. Therefore a bulb 13·5 centims. diameter contains $13{\cdot}5^3 \times 0{\cdot}5236 \times$ 1,000,000,000,000,000,000,000 or 1,288,252,350,000,000,000,000,000 molecules of air at the ordinary pressure. Therefore the bulb when exhausted to the millionth of an atmosphere, contains 1,288,252,350,000,000,000 molecules, leaving 1,288,251,061,747,650,000,000,000 molecules to enter through the perforation. At the rate of 100,000,000 molecules a second, the time required for them all to enter will be

12,882,510,617,476,500 seconds, or
214,708,510,291,275 minutes, or
3,578,475,171,521 hours, or
149,103,132,147 days, or
408,501,731 years.

had peculiar temptations. I venture to think that the greatest scientific problems of the future will find their solution in this Border Land, and even beyond; here, it seems to me, lie Ultimate Realities, subtle, far-reaching, wonderful.

"Yet all these were, when no Man did them know,
Yet have from wisest Ages hidden beene;
And later Times thinges more unknowne shall show.
Why then should witlesse Man so much misweene,
That nothing is, but that which he hath seene?"

THE BRITISH ASSOCIATION

GENERAL satisfaction is expressed with the Sheffield meeting. The people of the town and district did their best, amid many difficulties, to give the members of the Association a hearty reception, and they succeeded. The excursions on Thursday were well attended, and those who took part in them seem to have enjoyed themselves. At the meeting of the General Committee, Swansea was selected as next year's place of meeting, with Prof. A. R. Ramsay as president; the date of meeting is August 25. A letter was read from the Archbishop of York, warmly urging upon the Association to meet in the archiepiscopal City in 1881, when, for some unaccountable reason, the jubilee is to be celebrated, as we have already said, in the fifty-first year of the Association's existence. As the result of the important discussion in Section F on science teaching in schools, a committee was appointed for the purpose of reporting, in addition to other matters, whether it is important that her Majesty's inspectors of elementary schools should be appointed with reference to their ability for examining on scientific specific subjects of the code, the committee to consist of Mr. Mundella, M.P., Mr. Shaw, Mr. Bourne, Mr. Jas. Heywood, Mr. Wilkinson, and Dr. J. H. Gladstone.

REPORTS

Report of the Committee on Erratic Blocks, presented by the Rev. H. W. Crosskey, F.G.S. (Abstract.)

Several contributions of interest and importance have been received respecting the position and distribution of erratic blocks.

A granite boulder 3 × 2·5 × 2 feet has been found by Mr. Hall, in the village of Bickington, parish of Fremington. There is no similar rock nearer than Lundy Island, twenty-five miles west-north-west from the boulder and Dartmoor, twenty-five miles south by east. Its height above the sea is 80 feet.

Among the most remarkable erratic blocks yet described in the midland district, are those reported upon Frankley Hill, at a height of 650 feet above the sea. They were examined by the writer in company with Prof. T. G. Bonney, and the following is a summary of the observations made:—

A section of drift beds is exposed in a cutting of the new Hales Owen Railway passing through Frankley Hill. The section is as follows:—Permian clay, sand of clayey texture, yellowish sand, greyish sandy clay with brinter pebbly clay, somewhat sandy. The heights of the clays and sands are very irregular throughout the section which is in itself about 60 feet in depth.

Fragments of permian sandstone (which is exposed in a part of the section) are scattered through the sands and clays, but erratic blocks are rare. Indeed, one only—a green-stone—was noticed in the cutting itself, although others doubtless occur.

No part of this section can be called a "boulder clay"—if by "boulder clay" be meant either a clay formed beneath land ice, or a clay carried away by an iceberg and deposited on the sea-bottom, as the berg melted or stranded.

The various sands and gravels have all the appearance of being a "wash" from older beds, effected during the depression and subsequent upheaval of the present land surface. They are neither compactly crowded with erratics, nor are fragments of local rocks heaped irregularly together, and grooved and striated. The way in which the pieces of native rock are scattered through the beds, does not indicate any other force than that which would be exerted by the ordinary "wash" of the waters during the movements just mentioned.

The presence of a few erratics shows that the *wash* must have taken place beneath the waters of a glacial sea, over which icebergs floated.

These beds appear to have been formed in the earlier rather than the later part of the glacial epoch. In a field *on the summit of the section* a large number of erratics are to be seen which have been taken from a recent surface-drain. Twenty of these boulders are felsite, two are basalt, one is a piece of vein-quartz, and one is a Welsh diabase. They constitute a group of allied rocks, evidently from one district. Probably they belong to the great Arenig dispersion. Two of the felsites close to the group are of considerable size, the larger being about 6 × 4 × 2 feet. Similar blocks may be traced to the summit of the hill. One felsite boulder opposite the Yew Trees is about 4·5 × 3 × 2 feet, and is partly buried in the ground.

The height of the boulders above the sea is remarkable, their highest level being 650 feet.

This indicates a corresponding depression of the land, since no Welsh glacier could have travelled over hill and down dale to this summit-level. To render any such glacier work conceivable, the Welsh mountains must have stood at a height beyond any point for which there is the slightest evidence.

This group of boulders on Frankley Hill appears to have been dropped by an iceberg travelling from Wales upon the top of the clays and sands exposed in the railway cutting at a time when the land was depressed at least 700 feet. In the clays and sands upon which the summit group of erratics rests, we must have beds belonging to an earlier date than the *close* of the glacial epoch; and the erratics in the cutting must be discriminated from those left at the higher level.

Some remarkable boulders were described from the neighbourhood of Wolverhampton: (1) a striated boulder of felsite 11 × 3 × 3 feet; (2) one of slate, broken into two parts, but which, when whole, measured 11·25 × 6·25 × 3·5 feet; (3) one of granite about 4·75 feet in each dimension, and weighing about three tons.

Mr. D. Mackintosh traces the origin of the so-called "greenstone" boulders (more properly to be called diorites or dolerites) around the estuaries of the Mersey and the Dee.

The area in which they are very much concentrated is intensely striated, and nearly all the striæ point divergently to the south of Scotland, *i.e.*, between N. 15° W. and N. 45° W.

A large "greenstone" boulder has been found at Crosby, resting on a perfectly flat glaciated rock surface, with striæ pointing N. 40° W.

Additional presumptions in favour of the Scottish derivation of these boulders may be found (1) in the fact that nearly all these boulders consist of basic rocks similar to some found in the south of Scotland, and (2) in the extent to which they are locally concentrated on the peninsula of Wirral and the neighbouring part of Lancashire. Many fresh greenstone boulders have been lately exposed in the newest Bootle Dock excavation. The largest is 6 × 4·5 × 3 feet, and was found on the surface of the upper boulder clay. As a rule these boulders are excessively flattened and regularly grooved.

Mr. J. R. Dakyns describes the occurrence of Shap granite boulders on the Yorkshire coast. There are several at Long Nab on the north side of the Nab; one of these measures 3 cubic feet. Others are on the north side of Cromer Point; south of Cromer Point there are more till you come nearly to Filey. There is one measuring 3 × 2·5 × 2 feet on the top of the cliff about a mile from Filey. It is probably practically undisturbed, for the ground slopes inland from the cliff, and therefore, if it has been turned up in ploughing and moved, it cannot have been moved far, for no one would take the trouble to cart a huge boulder far up-hill.

There are several boulders of Shap granite on the shore along the north of Filey Bay, but none along the south till one reaches Flamborough Head. Several occur along the shore between Flamborough Head and Flamborough south landing; one of these measures 36 cubic feet. One may be seen rather more than a mile south of Bridlington Quay, and doubtless they have travelled still further south, since there is one built into a wall at Hornsea.

The destruction of erratic blocks is going on so rapidly that the Committee invite continued contributions of information concerning them.

Report of the "Geological Record" Committee, by W. Whitaker, B.A., F.G.S.—Since the last meeting of the Association the third volume of the "Geological Record" has been published. This gives an account of books, papers, &c., on geology, mineralogy, and palæontology published at home and abroad during the year 1876. The fourth volume (for 1877) is in the

press; and part of the MS. for the fifth volume (for 1878) is in hand. The average size of the three published volumes is 440 pages, each volume recording over 2,000 papers, &c.

Fifteenth Report of the Committee for Exploring Kent's Cavern, Devonshire. Drawn up by W. Pengelly, F.R.S.—Work during the past year has been carried on in the "High Chamber" and its branches. This chamber extends for about 53 feet in a north-westerly direction from the "Cave of Inscriptions." At its inner or north-western end it sends off two branches; the northern branch was excavated for about 12 feet, when the work was abandoned, as breccia, blocks of limestone, and crystalline stalagmite reached the roof and rendered further progress difficult and expensive. The "High Chamber" contains only breccia, the oldest mechanical deposit in the cavern, and the crystalline stalagmite which overlies it. Bones of bears and implements have been found in the breccia here, and some recent objects were found on or near the surface. The southern branch of the High Chamber is called the "Swallow Gallery," from a swallow-hole which occurs about 18 feet from the entrance. This has been explored for about 50 feet. It also contains only breccia, generally lying bare, but covered with crystalline stalagmite at the inner part of the chamber. Here too the remains consist chiefly of bear; a few implements have also been found. There were entrances to the cavern by the Swallow Gallery and through the swallow holes; but these were quite closed before the beginning of the "cave-earth era," and have since remained so. Excavations have also been made in Clinnick's Gallery; but here, as in former years, the number of "finds" has been small.

Prof. A. Leith Adams has availed himself of the collection of mammoth remains made during several years from Kent's Cavern, to illustrate his memoir for the Palæontological Society on "British Fossil Elephants." Extracts from this memoir are given in the report, and especial mention is made of a molar found in 1874 in the "Cave of Rodentia." Prof. Adams says:—"This tooth is one of the smallest milk-molars of any elephant with which I am acquainted, and is even more diminutive than the first milk-teeth of the Maltese pigmy elephants."

Report on the Miocene Flora, &c., of the North of Ireland, by W. H. Baily.—The plants occur, between two beds of basalt, in a deposit of brown and red bole, and immediately overlying a bed of pisolitic iron ore, which has been extensively worked. Twenty-five species of plants have been determined; they are most closely allied to the fossil flora of North Greenland, some of the forms also occurring at Bovey Tracy.

Sixth Report of a Committee consisting of Professors Herschel and Lebour, and Mr. J. T. Dunn, to determine the Thermal Conductivities of certain Rocks, showing especially the Geological Aspects of the Investigation.—The research and correspondence which it would require to complete a historical sketch of the attempts already made to determine by experiments the thermal conductivities of the most widely distributed terrestrial rocks, which the Committee proposed to prepare during the past year, are not so far advanced at present as to allow them to be comprehended in this year's Report. But the Committee hopes during the coming year by continuing its inquiries with the addition to its numbers of the names of Professors W. E. Ayrton and J. Perry, of the Imperial College of Engineering in Japan, to carry out the object of its undertaking, so as to exhibit the state of our knowledge of the data of thermal conductivity of those widespread kinds of rock which constitute the external materials of the globe.

The Committee has obtained during the past year some measurements of thermal conductivities both of rocks and ebonite, and india-rubber, and corroborates the very low value found by Prof. Stefan, of Vienna, for the conductivity of ebonite. It has also corrected some imperfections of its former tables, by showing that the values given in them have throughout been described too low, by about an eighth of their assigned values, and find that with this correction their results have been in close accordance with the measures that Sir William Thomson and other observers deduced of the conductivities of soils and rocks in places where underground thermometers have been sunk and read regularly for many years. The records of such thermometers in the grounds of the Royal Observatory at Greenwich have been preserved continuously for more than thirty years, and the last volume of "Greenwich Meteorological Reductions" contains the observations of their temperatures for twenty-seven successive years, 1847-73. This record (already used in part by Prof. Everett) might now afford a new and very valuable determination of the conductivity of sand and gravel strata, such as make up the materials of Greenwich Hill, upon which the Royal Observatory is placed.

Report of the Committee, consisting of Prof. Sir William Thomson, Prof. Clerk-Maxwell, Prof. Tait, Dr. C. W. Siemens, Mr. F. J. Bramwell, and Mr. J. T. Bottomley for commencing Secular Experiments upon the Elasticity of Wires, by J. T. Bottomley.—At the last meeting of the British Association, the arrangements for suspending wires for secular experiments in the tube which has been erected in the tower of the Glasgow University Buildings, and for observing these wires, were described and reported as complete. Some improvements have since been found necessary; but, so far as these are concerned, there is not much to add to the report then given.

The long iron tube has been closed at the top and bottom so as to keep out currents of air and dust, and the joints of the tube have been carefully caulked.

Some improvements in the cathetometer used for observing the marks on the wires were also found to be required, but the instrument is now satisfactory.

Six wires have now been suspended in the tube; their stretching weights have been attached to them, and they have been carefully marked and measured. These wires are suspended in pairs—two of gold, two of platinum, and two of palladium. One of each of the pairs is loaded with a weight equal to one-twentieth of its breaking weight, and the other of each pair with a weight equal to one-half of its breaking weight. The points of suspension for each pair are very close together, so that any yielding of the place of support affects both wires equally.

Each wire is marked with paint marks, and there are other marks on the wires and on the weights attached to them where positions have been determined. These marks are described in a laboratory book which is at present kept in the room of the professor of natural philosophy in the University of Glasgow. The measurements that have been made, and the experiments that have been undertaken in connection with the work assigned to the Committee, are all being entered in this book. This, however, can only be regarded as a temporary mode of keeping these records.

It is intended that the record in this book shall contain—

1. Description of the tube and arrangements for suspending the wires, and for suspending additional wires at future times, and description of the mode of attachment of the stretching weights.

2. Description of the cathetometer and method of measuring the changes, should there be any, in the lengths of the wires.

3. Description of the wires themselves, and record of experiments that have already been made on them as to breaking weight and Young's modulus of elasticity.

4. Description of the marks put on the wires, and record of the measurements that have been made as to the lengths of the wires and as to the relative positions of the marks at the time of suspending the wires.

The stretching weight and the clamps attached to the wires are engraved each with the amount of its weight in grammes. The measurements are all made in grammes and centimetres.

It seems desirable, considering the nature of the experiments that are just now commencing, that information regarding them should be preserved to the British Association in some appropriate way; and that provision should be made for recording every change that may take place, and for communicating from time to time to the Association such information as may be obtained.

In the report presented to the Association by this Committee last year, it was mentioned that experiments had been commenced in the laboratory of the University of Glasgow in connection with the present investigation on the effects of stress maintained for a considerable time in altering the elastic properties of various wires. These experiments are still being carried on, and results of interest and importance have been already arrived at.

The most important of these experiments form a series that have been made on the elastic properties of very soft iron wire. The wire used was drawn for the purpose, and is extremely soft and very uniform. It is about No. 20 B.W.G., and its breaking weight, tested in the ordinary way, is about 45 lbs. This wire has been hung up in lengths of about 20 feet, and broken by weights applied, the breaking being performed more or less slowly.

In the first place, some experiments have been tried as to the smallest weight which, applied very cautiously and with precautions against letting the weight run down with sensible velocity, will break the wire. These experiments have not yet been very satisfactorily carried out, but it is intended to complete them.

The other experiments have been carried out in the following way:—It was found that a weight of 28 lbs. does not give permanent elongation to the wire taken as it was supplied by the wire drawer. Each length of the wire, therefore, as soon as it was hung up for experiment, was weighted with 28 lbs., and this weight was left hanging on the wire for 24 hours. Weights were then added till the wire broke, measurements as to elongation being taken at the same time. A large number of wires were broken with equal additions of weight, a pound at a time, at intervals of from three to five minutes—care being taken in all cases, however, not to add fresh weight if the wire could be seen to be running down under the effect of the weight last added. Some were broken with weights added at the rate of one pound per day, some with three-quarters of a pound per day, and some with half a pound per day. One experiment was commenced in which it was intended to break the wire at a very much slower rate than any of these. It was carried on for some months, but the wire unfortunately rusted, and broke at a place which was seen to be very much eaten away by rust, and with a very low breaking weight. A fresh wire has been suspended, and is now being tested. It has been painted with oil, and has now been under experiment for several months.

The following tables will show the general results of these experiments. It will be seen, in the first place, that the prolonged application of stress has a very remarkable effect in increasing the strength of soft iron wire. Comparing the breaking weights for the wire quickly broken with those for the same wire slowly broken, it will be seen that in the latter case the strength of the wire is from two to ten per cent. higher than in the former, and is on the average about five or six per cent. higher. The result as to elongation is even more remarkable, and was certainly more unexpected. It will be seen from the tables that, in the case of the wire quickly drawn out, the elongation is on the average more than three times as great as in the case of the wire drawn out slowly. There are two wires for which the breaking weights and elongations are given in the tables, both of them "bright" wires, which showed this difference very remarkably. They broke without showing any special peculiarity as to breaking weight, and without known difference as to treatment, except in the time during which the application of the breaking weight was made. One of them broke with 44 lbs., the experiment lasting one hour and a half; the other with 47 lbs., the time occupied in applying the weight being thirty-nine days. The former was drawn out by 28·5 per cent. on its original length, the latter by only 4·79 per cent.

Tables showing the Breaking of Soft Iron Wires at Different Speeds

I.—Wire Quickly Broken

Rate of adding weight.	Breaking weight in pounds.	Per cent. of elongation on original length.
[1] Dark Wire		
½ lb. per minute	45	25·4
1 ,, 5 minutes	45¼	25·9
,, ,, 5 ,, ...	45¼	24·9
,, ,, 4 ,, ...	44¼	24·58
,, ,, 3 ,, ...	44¼	24·88
,, ,, 3 ,, ...	45¼	29·58
,, ,, 5 ,, ...	44¼	27·78
[1] Bright Wire		
1 lb. per 5 minutes	44¼	28·5
,, 5 ,, ...	44¼	27·0
,, 4 ,, ...	44¼	27·1

[1] The wire used was all of the same quality and gauge, but the "dark" and "bright" wire had gone through slightly different processes for the purpose of annealing.

II.—Wire Slowly Broken

Weight added and No. of experiment.	Breaking weight in pounds.	Per cent. of elongation on original length.
1 lb. per day. I.	48	7·58
,, II.	46	8·13
,, III.	47	7·05
,, IV.	47	6·51
,, V.	47	8·62
,, VI.	47	5·17
,, VII.	46	5·50
,, VIII.	47	6·92 Bright wire.
¾ lb. per day. I.	49	8·50
,, II.	48¼	8·81
,, III.	Broken by accident.	
,, IV.	46	7·55
,, V.	46	6·41
,, VI.	45½	6·62
½ lb. per day. I.	48	8·26
,, II.	50	8·42
,, III.	49	7·18
,, IV.	47	4·79 } Bright wires.
,, V.	46½	6·00 } Bright wires.

It was found during the breaking of these wires that the wire becomes alternately more yielding and less yielding to stress applied. Thus, from weights applied gradually between 28 lbs. and 31 or 32 lbs., there is very little yielding and very little elongation of the wire. For equal additions of weight between 33 lbs. and about 37 lbs. the elongation is very great. After 37 lbs. have been put on, the wire seems to get stiff again, till a weight of about 40 lbs. has been applied. Then there is rapid running down till 45 lbs. has been reached. The wire then becomes stiff again, and often remains so till it breaks.

It is evident that this subject requires careful investigation.

Report of the Committee for effecting the Determination of the Mechanical Equivalent of Heat.—The Committee had little to report this year, the work in progress being the protracted one of supplying a means of correcting errors in the determination of the temperature arising from the temporary changes of the fixed points of thermometers constructed of glass. They had learned with pleasure that an extensive series of experiments had recently been made by Prof. H. A. Rowland, of Baltimore, who, being unaware of what had been done by the Committee, had arrived at an equivalent almost identical with that determined by Mr. Joule.

Report of the Committee appointed for the Purpose of endeavouring to procure Reports on the Progress of the Chief Branches of Mathematics and Physics.—Owing to unforeseen circumstances no meeting of this Committee has taken place during the past year. It seems desirable, nevertheless, in order that the question of the reappointment of the Committee may be fully considered, and that there may be a full expression of opinions on the subject referred to it, that a statement should be made to the Section of the proceedings of the Committee, the more so since, in the hope that greater progress would have been made by this time, no report was presented at the last meeting of the Association.

The first matter discussed by the Committee was the character and general plan of the reports which they should endeavour to procure; the next was to what extent or in what manner the production of such reports could be aided by the Committee. Important contributions to the discussion of these questions are contained in written communications to the Committee from two of its members, Professors Clerk-Maxwell and Stokes. Prof. Clerk-Maxwell writes as follows:—

"Reports on special branches of science may be of several different types, corresponding to every stage of organisation, from the catalogue up to the treatise.

"When a person is engaged in scientific research, it is desirable that he should be able to ascertain, with as little labour as possible, what has been written on the subject and who are the best authorities. The ordinary method is to get hold of the most recent German paper on the subject, to look up the references

there given, and by following up the trail of each to find out who are the most influential authors on the subject. German papers have the most complete references, because the machinery for docketting and arranging scientific papers is more developed in Germany than elsewhere.

"The *Fortschritte der Physik* gave an annual list of all papers, good and bad, arranged in subjects, with abstracts of the more important ones. Wiedemann's *Beiblätter* is a more select assortment, given more in full.

"I think it doubtful whether a publication of this kind, if undertaken by the British Association, would succeed. Lists of the titles of the proceedings of societies and of the contents of periodicals are given in NATURE. These are useful for strictly contemporary science, and I do not think that a more elaborate system of collection could be kept up for long.

"The intending publisher of a discovery has to examine the whole mass of science to see whether he has been anticipated, but the student wishes to read only what is worth reading. What he requires is the names of the best authors. The selection or election of these is constantly done by skimming individual authors, who indicate by the names they quote the men whose opinions have had most influence. But a report on the history and present state of a science has for its main aim to enumerate the various authors and to point out their relative weight, and this has been very well done in several British Association reports, some of which are nearly as old as the British Association.

"There are some branches of science whose position with respect to the public, or else to the educational interest, is such that treatises or text-books can be published on commercial principles, either as books to be read by the free public, or to be got up by the school public.

"There is little encouragement, however, for a scientific man to write a treatise so long as he can, with much less trouble, produce an original memoir, which will be much more readily received by a learned society than the treatise would have been by a publisher.

"The systematisation of science is therefore carried on under difficulties when left to itself; and I think that the experience of the British Association warrants the belief that its action in asking men of science to furnish reports has conferred benefits on science which would not otherwise have accrued to it.

"There are so many valuable reports in the published volumes that I shall indicate only a few, the selection being founded on the direction of my own work rather than on any less arbitrary principle.

"First, when a branch of science contains abstruse calculations as well as interesting experiments, it is desirable that those who cultivate the experimental side should be conscious that certain things have been done by the mathematicians. The matter to be reported on in this case is not voluminous, but it is hard reading, and those who are not experts require a guide.

"Thus, Prof. Challis in 1834 gave a most useful report on the mathematical investigations by Young, Laplace, Poisson, and Gauss on capillary attraction, and Prof. Stokes in 1862 reports on theories of double refraction. This report may, indeed, be accepted as an instalment of the treatises which, if the desire of the scientific world were law, Prof. Stokes would long ago have written. It is meant, no doubt, as a guide to other men's writings, but it is intelligible in itself without reference to those writings. Such a report is a full justification of the existence of the British Association, if it had done nothing else.

"Another type of report is that of Prof. Cayley on dynamics (1857 and 1862). This seems intended rather as a guide in reading the original authors than as a self-interpreting document, though, of course, besides the criticism and the methodical arrangement, there is much original light thrown on the mass of memoirs discussed in it. It will be many years before the value of this report will be superseded by treatises.

"The report of the Committee on mathematical tables deals with a subject which, though not so abstruse, is larger and dryer than any of the preceding. It is, however, a most interesting as well as valuable report, and supplies information which would never have been printed unless the British Association had asked for the report, and which never would have been obtained if the author of the report had not been available.

"There are several other reports which are not mere reports, but rather original papers preceded by a historical sketch of the subject. No special encouragement is needed to get people to write reports of this kind."

Prof. Stokes thus expresses himself on the subject:—

"It seems to me that reports on the progress of science may be of two kinds, with somewhat different objects in view; and in considering the best mode of meeting these objects, it may be well to keep the distinction in view.

"First, there is a report, the object of which is to prepare a sort of repertorium of what has been done in a particular branch of science since the date of the last report of similar character in the same branch of science.

"A report of this kind should present the reader with a brief account of the leading aim and chief results of the various memoirs which have been published within the time on the branch of science to which it relates; the writer should not be expected to criticise the memoirs, except in plain instances of errors or imperfections, but the responsibility of sifting the wheat from the chaff should in the main be left to the reader.

"Secondly, there are reports of a more comprehensive and far more critical character. These should be made at wider intervals, should take a more comprehensive view of the subject, and should be highly critical, sifting out the substantial acquisitions that had been made to the branch of science to which they refer.

"Each kind of reports are of value, though in somewhat different ways. The first aids the individual in keeping himself up to the progress of science around him—a progress in which from his position he may be expected to take part and to exercise influence. They lighten to him the labour of search, but teach him to exercise his own discrimination.

"The second should be a material aid to the student in making himself master of what was really of value, and help him to avoid wasting his time on what was of little importance, and aid him in judging of the relative importance of different lines of research.

"Reports of the first kind may be much promoted by the work of committees. The division of labour lightens the task, and the feeling of co-operation carries a man through labour which otherwise, as the man is likely to have a good deal else to do, he might hesitate to undertake.

"Reports of the second kind eminently demand the hand of a master, and the hand of a master is not always free. I doubt much if the appointment of committees would aid much in the preparation of *good* reports of this class, and unless reports are thoroughly good they are better, perhaps, not attempted. I do not see what is to be done except to work a good man *when you can get him*."

It is evident that the distinction here pointed out by Prof. Stokes has an important bearing on the question of the re-appointment of the Committee. The work required for the production of reports intended simply as systematic records "of the leading aim and chief results" of published investigations, would be merely that of careful compilation. It would not only be possible to divide work of this kind among a considerable number of contributors, but to get it done at all such division of labour would be necessary, and accordingly reports of this class could only be furnished by committees. On the other hand, a report which is of the nature of a critical survey of the condition of knowledge in any branch of science, and is intended to indicate the relative value of different investigations, requires to possess a unity of plan and thought which can only result from its being the work of an individual author possessing a complete mastery of his subject. In such a case the function of the committee would be confined to the suggestion of the subject and to requesting some qualified person to report upon it—a function which hitherto has been discharged by the Sectional Committees of the Association.

Report of the Committee, consisting of Prof. Sylvester and Prof. Cayley, appointed for the Purpose of calculating Tables of the Fundamental Invariants of Algebraic Forms.—The valuable services of Mr. F. Franklin, of the Johns Hopkins University, has computed, under Prof. Sylvester's inspection, the *ground forms* (otherwise called the fundamental invariants and covariants) of binary quantics of the 7th, 8th, and 10th orders respectively, thus rendering the list of tables of such forms complete for quantics of all orders up to the 10th inclusive.

The tables of the *Grundformen* of the seventhic and tenthic are published in the *Comptes Rendus de l'Institut*, 1878, 1879; the table of the *Grundformen* of the ninethic in the *American Journal of Mathematics*, March, 1879, and in a future number of that journal will shortly also appear the intermediary tables of the Generating Functions from which such *Grundformen* are deduced.

These tables, in addition to those previously constructed, will, it is believed, form a valuable, and (for the present) a sufficient, basis for the prosecution of this kind of research in what regards the theory of single binary quantics, leaving a wide field still open for computations of a similar nature connected with systems of binary quantics and binary and semi-binary quantics, single or in systems.

Report of the Committee on Atmospheric Electricity in Madeira, by Dr. M. Grabham.—Daily observations in Madeira extremely monotonous, showing very little variation, though suggesting the importance of a station so uniform in weather for the careful observance of diurnal and seasonal changes. The writer, giving himself to the observation of the regular winds and breezes, traces the steady rise of electricity in the early morning to a maximum at 11·30 A.M., which declines after much steadiness for two hours, at first suddenly and then very gradually towards night.

Remarkable fluctuations are noticed during the formation of the maximum which the writer ascribes to masses of cloud on moist air. A description follows of the daily formation of a thin stratum of cloud during fine calm weather which varies slightly in altitude in accordance with temperature and barometric pressure. The electricity below this cloud is always positive and moderately strong. In the cloud itself it is more feeble but of the same sign. Above the cloud at the station where the observation was taken it was very feeble and irregular but always positive. In warmer weather the vapour does not condense into cloud but appears as a blue transparent haze from above, and presents the same electrical indications.

The writer states that all observations in his own garden were vitiated or mitigated by the presence of lofty trees.

The highest potential was observed upon a rock ninety feet high, a few metres from the shore in the Bay of Funchal.

The thinness of the currents of air constituting sea breezes was demonstrated by flying a kite vertically beyond into the true wind blowing in a contrary direction. Abortive attempts were made to bring down the upper electricity through the lower currents. The electricity of the general north-east wind which is identical with the trade wind was found on the heights at the east end to be uniformly moderate and positive.

At the approach of rain-clouds at the termination of a period of fine weather the atmosphere invariably gives increased readings and no negative observations were recorded.

A short description follows of the L'este, a kind of sirocco to which Madeira is occasionally subject and which blows with great force on certain limited mountain districts bringing sand, birds, and other evidence of a distant origin. This wind is extremely dry, in a temperature of 85° the dew points being depressed below freezing. Electrically this wind in its integrity gives no indication of any change whatever except by faint fluctuations about the earth reading.

The writer also notices a very highly electrical condition during the prevalence of L'este wind, of certain clouds which lie quietly among the mountains, though tossed and tumbled on their upper surfaces; he hopes to be able to connect their forms and immobility with their electrical change.

Report of the Committee on Mathematical Tables, by James Glaisher.—In the course of the year the factor table for the fourth million has been printed and stereotyped, and is nearly ready for publication. The manuscript of the factor table for the fifth million is complete. The table for the sixth million is complete as far as the factors entered by the sieves are concerned, but the factors obtained by the multiple method still need entering, and the whole has to be verified. The mode of calculation was described in last year's report, and a more complete account will appear in the introduction to the fourth million. The present report contains the result of the enumeration of the primes in the fourth million, and a list of long sequences of composite numbers occurring in it. The report also contains a table of the first seven Legendrian coefficients, viz., $P^n(x)$ for $n = 1$ to $n = 7$, where

$$P^1(x) = x,\ P^2(x) = \tfrac{1}{2}(3x^2 - 1),\ P^3(x) = \tfrac{1}{2}(5x^3 - 3x),$$
$$P^4(x) = \tfrac{1}{8}(35x^4 - 30x^2 + 3),\ \&c.,$$

each for a hundred values of the argument.

Report of the Committee on Luminous Meteors, by James Glaisher.—After recording the regret the Committee felt at the loss of two of the most active workers—Mr. Greg by his retirement, and Mr. Brooke by death—the report stated that the very unfavourable weather had generally caused only very meagre views of the annual star showers of October, December, January, and April to be seen. The major showers of August had also been hidden from view, owing to the unfavourable weather. The report then dealt in detail with the accounts of conspicuous detonating fire-balls that had occurred in the United States on August 11 and December 18, 1878, and on January 27, 1879; in Bohemia and Saxony on January 12, 1879, and in England on February 22 and 24, 1879, the real paths of all of which had, to a greater or less degree of certainty and closeness, been approximately ascertained. The rest of the report was devoted to a description of the past year's aërolites. The expected return of Biela's comet to its perihelion in the present year, leading a shower of shooting stars to be looked for with much confidence among astronomers on November 27 next, is to be taken advantage of to report next year on meteor showers. As in former years the Committee were under great obligations to Prof. A. S. Herschel for the labour he had bestowed on the report.

Report of the Committee for Calculating Tables of Sun-heat Coefficients, by Rev. Dr. Haughton.—A table showing the total heat received by various latitudes from the sun in the course of a year had been formed; and the work would be completed by next year. The results already obtained have appeared in the *Proceedings* of the Royal Dublin Society.

Report of the Committee consisting of the Rev. H. T. Barnes Lawrence, Mr. Spence Bate, Mr. H. E. Dresser (Secretary), Mr. J. E. Harting, Dr. Gwyn Jeffreys, Mr. J. G. Shaw Lefevre, M.P., Prof. Newton, and the Rev. Canon Tristram, appointed by the Council, for the purpose of Inquiring into the Possibility of Establishing a Close Time for the Protection of Indigenous Animals.—Your Committee has gratefully to acknowledge the resolution of the Council of the Association, whereby your Committee has been not only reappointed but also instructed to report to the Council in case of any action being required. Your Committee begs leave to state that no such emergency as was provided for by this instruction has arisen since the presentation of its last report. Notwithstanding complaints that are occasionally heard, your Committee believes that public opinion continues strongly in favour of the close time principle, as applied to indigenous animals; and on the part of Her Majesty's Government no steps have been taken to carry out the recommendations of the Scottish Herring Fishery Commissioners, upon which your Committee deemed it its duty to animadvert last year. The Bird Preservation Acts, though doubtless evaded in some places, in general appear to work well, and to be enforced without difficulty when occasion requires. Having regard to future contingencies, your Committee ventures to solicit its reappointment with the instructions as to reporting to the Council in case of emergency.

Report of the Committee consisting of Mr. Sclater, Dr. G. Hartlaub, Sir Joseph Hooker, Capt. F. M. Hunter, and Prof. Flower, appointed to take Steps for the Investigation of the Natural History of Socotra.—The Committee have not held any formal meetings, but have been in frequent communication with each other on the subject.

The best time for the exploration of Socotra being from November to March, the Committee were not able to make the necessary arrangements last autumn. Next winter, however, they believe that Col. H. H. Godwin-Austen, than whom no more competent naturalist could be found, will be able to undertake an expedition to Socotra, and to make a thorough investigation of its natural history. Col. Godwin-Austen has applied to the Surveyor-General of India for the use of some of the assistants on his staff, and proposes to make a complete topographical survey of the island during the expedition.

It is estimated that the total cost of the expedition will be about 300*l*. Of this 100*l*. granted by the Association last year, has been received by the Committee and deposited in the London and County Bank at interest. The sum of 175*l*., having been devoted to this same purpose out of the Government Fund of 4,000*l*. administered by the Royal Society, has been paid to Col. Godwin-Austen, and has been added to the account at the London and County Bank.

There remains, therefore, only 25*l*. requisite to complete the sum of 300*l*., which the Committee consider will be required for the expedition.

The Committee request that the Committee for the investigation of the Natural History of Socotra may be re-appointed with the additional name of Col. H. H. Godwin-Austen, and that the balance of 25*l*. necessary to complete the estimate of expenditure may be placed at their disposal.

Report of the Committee on an Instrument for Detecting Fire-damp in Mines, by Prof. G. Forbes.—From the rough model shown last year the Committee had constructed two new instruments, which appeared to them to answer the purpose of measuring the quantity of fire-damp in a coal mine. The one was of a large size, and was worked by an electric battery. The other was small, portable, easily worked, and it answered all the purposes for which it was required. Both instruments were founded upon the facts that sound travels quicker in light gases than in dense ones, and that air which is contaminated with fire-damp is lighter than pure air. The velocity of sound in different qualities of air was compared by noting the lengths which must be given to a brass tube to cause it to resound to a tuning-fork. The accuracy of the instrument was such that the percentage of fire-damp could be determined with an error of considerably less than 1 per cent. On Monday the Committee were enabled to descend the Wharncliffe Silkstone Colliery, in the neighbourhood of Sheffield, by the kindness of the manager, Mr. George Walker, who accompanied them with a number of gentlemen interested in the experiments. This pit was at a depth of 200 yards. Mr. Walker had kindly arranged to stop the ventilation and the pit at the end of the workings. After proceeding for a mile through the galleries they reached this spot, where they hoped to find a large amount of fire-damp. But only a slight quantity was to be found, the Davy lamp generally showing but a feeble blue cap, and the Forbes indicator registering only small percentages. Disappointed here, they were taken by Mr. Walker to another working, where it was thought possible there might be some gas. In a crevice in the roof a flow of gas was found, forming a stratum of light gas. The instrument indicated quantities which gradually increased, as the tube got filled with the air in the crevice, from 14 to 28 per cent. But the small quantity of gas rendered the experiment unsatisfactory, and the Committee were then taken to a disused part of the mine, where it was known there was a blower. Gas in sufficient quantities was found, and the instrument registered gas with more readiness than the Davy lamp. But the greatest quantity registered was 6 per cent., or twelve times the smallest quantity which the indicator detects. There was in the present form of the instrument a difficulty in filling the tube with the air of the place under examination, and the Committee considered that it would be well to alter the instrument so as to obviate the difficulty. From the experiments they could assert that this instrument was capable of detecting and measuring fire-damp even in small quantities.

SECTION A—MATHEMATICAL AND PHYSICAL

On Lightning Protectors for Telegraphic Apparatus, by W. H. Preece.—For many years it was not the practice in England to protect telegraphic apparatus from the injurious effects of atmospheric electricity because the damage done was so insignificant, and because the remedy was found to be worse than the disease. But as telegraph systems increased, as the country became enveloped in one vast network of wires, it was found that the damage done became considerable, until, in fact, about 10 per cent. of the apparatus in use were in one year damaged.

Lightning protectors then became essential. Many forms were tried based on the fact that when a discharge takes place through a non-conductor such as dry air, at the moment of discharge the resistance along the line of discharge is practically nothing, and therefore all the charge is conducted away. According to Faraday, "the ultimate effect is exactly as if a metallic wire had been put into the place of the discharging particles" ("Researches," series xii.). Most of those tried failed.

The survival of the fittest has been exemplified in the "plate" protector. In this form—one of the earliest introduced—one thick plate of brass is in connection with the earth, and another similar plate in connection with the line, is placed above it, but separated from it by paper, or by insulating washers. The lightning entering the wire bursts across the paper or air-space in preference to passing through the apparatus, and thus escapes to earth.

An important modification of this plate discharger has been made by Dr. Werner Siemens, who, by serrating, or grooving with a pointed tool the opposing faces of the two plates at right angles to each other, converted them into a conductor which was supposed to be one composed of an infinite number of opposing points. The remarkable action of points in facilitating discharge is well known, and their introduction into lightning protectors occurred very early in the annals of telegraphy by Mr. C. V. Walker, F.R.S.

Messrs. Siemens's arrangement, very pretty in theory, never carried conviction of its value to the mind of the author, because protectors so prepared never singled themselves out as evidently superior to others that were not so prepared, and while the intersection of the grooves certainly formed mathematical points, they did not form physical or mechanical points, and it is upon the action of this latter kind of points that such remarkable electrical effects are produced.

Dr. Warren de la Rue having very kindly placed his well-known battery of 11,000 cells at the disposal of the writer, he prepared four plate-protectors identical in dimensions, excepting that two were serrated, and two were not. The two plates were separated from each other by narrow ebonite washers ·01 inch thick. The upper plate was placed in connection with the positive pole, and the lower plate with the negative pole. The number of cells were increased until a continuous current of electricity flowed.

1.—*Plain Plates*

Number of Cells.	Effects produced.
1,000 ...	Slight sparks commencing on completing circuit.
1,080 ...	Sparks evident.
1,200 ...	Sparks frequent and abundant.
1,500 ...	Continuous arc.

2.—*Serrated Plates*

Number of Cells.	Effect produced.
1,000 ...	Sparks just commencing on making contact.
1,080 ...	Sparks evident.
1,200 ...	Sparks frequent.
1,500 ...	Continuous arc, but fitful.

2,000 cells in each produced a continuous stream of electricity. The effect with 1,500 cells was decidedly more marked with the plain plates than with those serrated. The experiments were extremely pretty, and very decided in their character. Hence it appears that grooving is not only of no use, but that it rather deteriorates the value of the protector.

These experiments confirm very decidedly the accuracy of the figures obtained by Dr. Warren de la Rue and Mr. Müller on the striking distance between two flat disks given by them in their paper read before the Royal Society (*Phil. Trans.*, vol. 169), where it was shown that 1,200 cells struck across ·012 inch. Here 1,000 struck across ·01 inch, which agrees perfectly with the curve produced by those observers.

It is the practice in the Post Office telegraph department to keep these plates apart by thin paraffined paper ·002 inch thick, so that the air surface is really much thinner than that experimented upon, and the striking difference of potential only 250 volts.

Messrs. De la Rue and Müller have shown that for points and various kinds of surfaces opposed to each other, plane surfaces act the best for potentials less than 1,500 volts, and that points are only efficient for high potentials. Now as it is doubtful whether atmospheric electricity causes much higher potential than 1,000 volts, it is clear than plane surfaces are the most effective for protecting apparatus. It is quite certain that such plates, plain and smooth, separated by an air space ·002 inch thick, will form very efficient lightning protectors.

The author is very much indebted to Dr. Warren De la Rue for the performance of the experiments in his laboratory.

Experiments made to determine the Friction of Water upon Water at Low Velocities, by Rev. S. Haughton, M.D., D.C.L.—The author's intention, in commencing the experiments, was to ascertain the co-efficient of tidal friction, and also to ascertain the elevation of water at the equator or pole, necessary to cause a current; and both these results he hopes to secure with some approach to accuracy.

The experiments were conducted by means of a spherical ball of granite, unpolished, which was suspended by a pianoforte wire, and allowed to hang freely; from the brass collar by which the ball was suspended an index projected on each side, the pointed ends of the indices traversing a graduated horizontal circle, whose centre corresponded with the line of suspension. The suspended ball was immersed in water contained in an iron tube.

On the Tension of Vapours near Curved Surfaces of their Liquids, by G. F. Fitzgerald.—The paper is intended to give a physical explanation of the fact that the tension of a vapour in

contact with the surface of its liquid when that surface is convex or concave is greater or less respectively than when flat. It rests upon the assumption that evaporation is not purely superficial but that molecules are emitted from a certain depth beneath the surface of a liquid. From this it follows that the chances of escape of a molecule from a given depth below a convex surface are greater, and from a concave less than from a flat one. Taking the depth from which emission takes place as very small compared with the radii of curvature of the surface, the author has deduced the same formula for the increase or diminution of tension as Sir W. Thomson deduced from capillary phenomena.

Etherspheres as a Vera Causa of Natural Philosophy, by Rev. S. Earnshaw, M.A.—The author, assuming an admitted parallelism between the phenomena of light and heat, proceeds by means of three hitherto overlooked propositions in natural philosophy to establish the universal existence of what he has denominated *etherspheres*, the third of his propositions being—"Every atom of matter in the universe is surrounded by an ethersphere of its own." The following is the system of nature which he finds sufficient for his purpose:—

1. In nature there are two distinct substances, matter and ether, neither of which has any power to attract or repel the other.

2. Matter consists of atoms which attract each other with forces varying according to the Newtonian law (distance)$^{-2}$.

3. The atoms of bodies of the same kind are alike in all respects; atoms of bodies of different kinds differ from each other in size, and possibly also in other respects, such as shape, &c.

4. Atoms, whether of matter or of ether, are incapable of experiencing any change of figure or dimensions; and they are all assumed to be of such geometrical forms as cannot fill space.

5. From the phenomena of light it has been inferred that atoms of ether repel each other with a force varying as (distance)$^{-4}$.

6. Every atom of matter is impervious to ether, and acts on ether in no other way than by pressure of contact.

7. A portion of space filled with matter is necessarily void of ether; and all space void of matter is pervaded by ether.

8. The enormous velocity of light in free space has led to the opinion that very great must be the repulsive power of ether on ether; and it seems to follow from this that an ether atom will experience great difficulty in moving from one part of the ethereal medium to another. Except as waves and currents, ether motion will be under great restraints, and especially shall we see this when we also remember the high power (viz., the fourth) of its inverse law of force.

9. In free space light is believed to be transmitted with the same velocity in every direction, and from this we infer that the atoms of ether are all spherical in form.

The following is the author's definition of an ethersphere:—

All space not filled by matter is pervaded by ether, so that every atom of matter is surrounded by ether, but this is not what is included in the word "ethersphere." The author shows that if any portion of space be rendered void of ether from any cause whatever, that space has become void of the repulsive forces which were centred within it, and that, consequently, when these forces are taken away the medium outside the space will draw closer towards that space; and if the space be occupied by an atom of matter, the density of the surrounding ether will be greater than before, and the ether, being in contact with the atom at its surface, will press upon it. This *excess* of ether about the vacant space above its original quantity constitutes the ethersphere; and though this gathering together of ether about the space now occupied by the atom is a consequence of the presence of the atom, it is in no way owing to its action on the ethereal medium.

The author then argues that if every material atom, so must every compound system of atoms, *i.e.*, every material body, whether gaseous, liquid, or solid, have an ethersphere, which not only surrounds the whole body, but also penetrates the interstitial spaces of the body which lie between its atoms.

By means of these etherspheres the author believes the phenomena of heat may be satisfactorily accounted for, on the supposition that the ethereal medium is the medium of heat as well as of light. They are shown in the original memoir itself to have a remarkable bearing also on the phenomena of magnetism, electricity, galvanism, and the various sciences connected with the agency of imponderables. He therefore concludes that etherspheres constitute a *vera causa* the existence of which in nature is as certain as is that of the ethereal medium itself, about which no philosopher expresses doubt in the present day.

On the Fundamental Principles of the Algebra of Logic, by Alexander Macfarlane, M.A., D.Sc.—In a work recently published, entitled "The Algebra of Logic," the author has investigated anew the foundations of that branch of mathematical analysis which was originated by Boole in his celebrated treatise on "The Laws of Thought." In making this inquiry the author has studied the contributions to the subject made by Harley, Venn, Jevons, and others.

The difficulty and apparent irrationality of Boole's calculus is due to the fact that it is founded on the old and inadequate theory of the operation of the mind in reasoning about quality. That theory supposes that the mind, in forming a compound conception out of two simple conceptions, necessarily considers the second of these as limited by, and in a measure dependent upon, the first; in the theory which the author advances it is maintained that the mind may, on the other hand, form compound conceptions in which the second element is entirely dependent on the first; and, on the other hand, compound conceptions, in which the two elements are mutually independent.

The author considers that the fundamental notion in this branch of analysis is that of a collection of homogeneous objects having differentiating characters. The collection of objects, so far forth as they are homogeneous, may be denoted by u (as they form the universe considered in the particular investigation); a differentiating character may be denoted by a small letter, as x. The symbol x applies to, and is entirely dependent upon, u. The arithmetical value of u is the number of the objects considered, and may be singular, plural, or infinitely great. The arithmetical value of x is the ratio of the number of the objects which have the character x to the whole number of objects considered. The author then explains the meaning of the letters and symbols in this system of logic.

On Synchronism of Mean Temperature and Rainfall in the Climate of London, by H. Courtenay Fox, M.R.C.S.—The object of the paper is by the examination of a long series of facts to ascertain whether there be any law which regulates the *occurrence at the same time* of extremes of temperature and rainfall, so far as we can ascertain it in the English climate.

The facts used are the rainfall and mean temperature as for the Royal Observatory in each month and season for 66·67 years. The mean temperature from 1813 to 1840 is that computed by Mr. James Glaisher, F.R.S., (*vide Philosophical Transactions*, 1850, part 7); and from 1841 to the present time, it is from direct observation. The rainfall from 1830 to 1840 is derived from sundry observations about London collated by Mr. George Dines, and from 1841 to the present time it also is from direct observation at the Greenwich Observatory.

The author has constructed tables *for each month*, in which the sixty-seven (or sixty-six) years are arranged in the order of the mean temperature of that month, beginning with the coldest and ending with the warmest, and also arranged in like manner in the order of their amount of rain. The sixty-seven years are then divided, as nearly as can be, into five equal sections, of which the middle section is termed average years; the division on each side of the average are termed cold and warm, dry and rainy, respectively; while the extreme sections are qualified by the word *very*, being called very cold, very warm, very dry, and very rainy, respectively. We have thus a pretty fair division of the series of years in both these characters. What has been done for each month has been also done on exactly similar principles for each season and for the whole year. The results found were:—

1. In the winter months, cold tends to be synchronous with dryness, warmth with large rainfall.

2. In the summer months, cold tends to be accompanied by much rain, warmth by dryness.

3. Rainy years tend to be either very cold or very warm, whilst years of drought tend to assume an average temperature.

Experiments on the Influence of the Angle of the Lip of Rain Gauges on the Quantity of Water Collected, by Baldwin Latham, C.E., M. Inst. C.E., F.G.S., F.M.S.—The author having observed that, in the ordinary pattern of the Glaisher gauge, in high winds the rain was often driven up the sloping lip and into the gauge, thought that if the rim of the gauge were made very acute, having a sharp knife edge and equal angles both inside and outside the gauge, any rain which might strike upon the outer angle on one side of the gauge might be thrown into the

gauge. Rain striking upon the inner and opposite side of the gauge would be thrown out, and so an equilibrium rim would be constructed, as the gain on one side would be balanced by the loss on the other side.

With this view, the author had an 8-inch gauge made and tested alongside of an 8-inch Glaisher gauge. The sloping lip of the Glaisher gauge had an angle of 45° from the perpendicular, and the rim of the equilibrium gauge was ·8 in. deep, ·18 in. in thickness, sloping off on both sides at an angle of 3° from the perpendicular. Both gauges were fixed at Croydon, 4 feet above the ground, and 259 feet above Ordnance datum. These gauges had been working side by side for 551 days, from January 5, 1878, to July 5, 1879, during which period rain or snow has fallen upon 306 occasions. Upon 43 occasions it was found that the rain collected in the Glaisher gauge exceeded, by a small amount, the rain in the equilibrium rim-gauge, and on two occasions the quantity in the new gauge exceeded that in the Glaisher gauge. Upon 261 occasions the rain in both gauges was absolutely equal. On all occasions, it should be observed, the rain from both gauges was invariably measured in the same graduated measuring glass. On the 45 occasions when the Glaisher gauge collected most rain, the wind without exception was high. On the two occasions when the equilibrium rim-gauge collected more rain than the Glaisher gauge, it was probably due to dew, the equilibrium gauge presenting a larger surface for condensation than the other gauge. As the Glaisher gauge was not calculated to contain snow, all falls of snow are recorded in the equilibrium rim-gauge, which is constructed to hold about one foot in depth of snow.

The total quantity of rain collected in the Glaisher gauge during the period of observation, plus the snow as caught in the equilibrium rim-gauge, was 46·68 in., and the quantity collected in the equilibrium rim-gauge was 46·45 in., showing a difference of but half per cent. In all probability, however, the small excess measured by the Glaisher gauge would tend to compensate for the losses by evaporation in periods of small rainfall and at other times, and therefore, as a measuring gauge, the Glaisher pattern of gauge, when tested by a gauge of the description mentioned, gives results in practice which may be taken as correct.

Summary of Results

Date.	Total number of days' experiments.	Number of days when rain fell.	Amount of rain collected by Glaisher gauge.	Amount of rain collected by equilibrium rim-gauge.	Times when Glaisher gauge in excess of equilibrium rim-gauge.	Times when equilibrium rim-gauge in excess of Glaisher gauge.
1878.			inches.	inches.		
January ...	31	17	1·145	1·115	6	—
February ...	28	15	1·440	1·430	2	—
March	31	10	1·300	1·295	1	—
April	30	17	3·940	3·940	0	—
May	31	22	3·480	3·460	4	—
June	30	13	3·205	3·190	1	—
July	31	11	·595	·600	0	1
August ...	31	20	5·725	5·690	7	1
September ...	30	11	1·015	1·010	1	—
October ...	31	18	2·140	2·135	1	—
November ...	30	22	3·775	3·735	8	—
December ...	31	20	1·460	1·455	1	—
1879.						
January ...	31	13	2·610	2·610	0	—
February ...	28	22	3·380	3·360	4	—
March	31	13	·540	·540	0	—
April	30	19	2·535	2·515	4	—
May	31	18	3·600	3·595	1	—
June	30	20	3·690	3·680	2	—
July	5	5	1·105	1·095	2	—
Totals ...	551	306	46·680	46·450	45	2

On the Retardation of Phase of Vibrations transmitted by the Telephone, by Prof. S. P. Thompson.—It was predicted from theoretical considerations by Dubois-Reymond that a difference of phase, amounting to a quarter of a complete vibration, would be found to exist between the diaphragms of two associated Bell telephones, the receiving telephone being a quarter of a vibration behind the transmitter. A more complete theory, worked out independently by Helmholtz and Weber, gave a somewhat contradictory result, and required only a small difference of phase. Recently König in a series of delicate experiments, effected an optical comparison by the method of lissajous of the vibrations of a pair of telephones, replacing the vibrating discs by tuning-forks armed with mirrors. The experiment is a delicate one, and is performed under condition not free from objection. The author has proposed the following method of observing. A pair of Bell telephones are suspended by wires of about a metre in length, so as to oscillate as pendulums, to frames so disposed as to avoid the possibility of any mechanical transmission of the vibrations. Below the point of rest of each telephone, and at some little distance from it in the plane of its swinging, is placed a steel magnet. After the lengths of the wires have been so adjusted that the telephones will swing in identical periods, one telephone is set swinging. As it alternately approaches and recedes from the magnet, the induced currents traversing the second telephone set it swinging. In every case the difference of phase observed amounted to one quarter.

In the case of those telephones which transmit vibrations by varying the resistance of the circuit, instead of varying the electromotive force, there is no such retardation of phase produced in the ordinary electromagnetic receiver. If, however, the current so transmitted is first passed through an induction coil, a retardation of phase of one quarter is produced, and in the case of several successive inductions the retardation amounts to an additional quarter for every additional induction. This remark applies only to vibrations of harmonic and quasi-harmonic type. Vowel sounds, which consist of compound harmonic vibrations, are unchanged to the perception of the single ear, which is unable to distinguish differences of phase, or between compound sounds which differ from one another only in the difference of phase of their components. The vibrations of consonantal sounds, on the contrary, depart more and more widely from their original type at each successive induction.

In the case of Edison's motographic or electro-chemical receiver, the velocities, not the displacement of the disc, are proportional to the strength of the currents received. Hence vibrations already retarded one quarter in transmission, as is the case with those of the carbon transmitter in conjunction with its induction coil, always used with this instrument, are restored to their primitive phase. The vibrations of this receiver therefore agree in type, not with the vibrations of the induction current (which correspond to the derived function of those of the original vibration), but with those corresponding to the function of which the vibrations of the induction current are the derivate; that is to say, they agree in type with the primitive vibrations of whatever form. Hence in the receiving telephone of Edison consonantal sounds which depart widely from the purely harmonic type are better rendered than in a telephone which like that of Bell both retards the vibrations in phase and alters them in type.

On some New Instruments recently constructed for the Continuation of Researches on Specific Inductive Capacity, by J. E. H. Gordon, B.A.—Mr. Gordon exhibited and explained the following new instruments which he has arranged during the last year:—

1. A miniature five-plate induction-balance, similar in principle to the large balance exhibited at the Dublin meeting, but intended for the examination of crystals and other precious substances which cannot be obtained in sufficiently large quantities for the large balance.

The large balance requires the dielectric plates to be 7 inches square and $\frac{1}{2}$ to $\frac{3}{4}$ inch thick. For the small balance it is sufficient to make them 2 inches square and $\frac{1}{8}$ inch thick.

2. A gauge for measuring the thickness of the dielectric plates to $\frac{1}{1000}$ inch.

3. A new form of quadrant electrometer for use with the small induction balance.

The capacity of the smaller plates of the little induction balance is so minute that when they are attached to the quadrants of the electrometer of ordinary construction (Elliott pattern) disturbances in them produce hardly any effect on the needle, on account of the much greater capacity of the quadrants of the electrometer.

In order to construct an electrometer whose quadrants should

have very small capacity, and which should yet be very sensitive, the author has arranged the quadrants as pieces of a flat disk, only 1 inch in diameter, and the needle has been bent round them so as to be acted on by both their upper and lower surfaces and their outside edge.

4. A new rapid commutator.

This was invented by Prof. Cornu, of the École Polytechnique, Paris, who had the great kindness to devise it for the author of this paper, who, when M. Cornu took up the matter, had just constructed three different instruments for the experiments for which this one is intended, all of which had proved unsuccessful.

Some preliminary experiments with M. Cornu's instrument have shown that it promises to be entirely satisfactory. It can be used with either the large or small induction balance on the one hand, and with a Holtz machine or battery of 500 or more cells on the other. It reverses the electrification of the plates of the balance eighteen times per second, and between each reversal, short circuits, and puts to earth both poles of the induction balance and both poles of the battery. By altering two screws it can be arranged to short circuit and put to earth the poles of the induction balance only, and to insulate the battery poles.

5. Driving-wheel for the Cornu commutator.

All the instruments have been constructed by Mr. Kieser, of the firm of Elliott Brothers.

SECTION C

GEOLOGY

Opening Address by Prof. P. Martin Duncan, F.R.S., Vice-President of the Geological Society, President of the Section

Everyone who is interested in the science which is especially considered in this Section of the British Association for the Advancement of Science must be impressed with the importance of the geological construction of this district in determining its physical geography, in producing the features of its landscapes, and in originating and developing many of the industries of the busy town of Sheffield.

It was inevitable that you should be addressed, at the commencement of your labours, upon the subject of the carboniferous formation, especially as the intention of this peripatetic congress is to advance science amongst those who require it. It will therefore be my privilege to bring before you some of the more important generalisations of the day, and some other considerations regarding the great formation which is so fully developed in this part of England; trusting that whilst many of you will submit to be reminded of the results of the labours of the men who have established our science and of those of yourselves, some who desire further information than they have hitherto obtained may be advanced in knowledge.

Of all geological formations, the carboniferous is the most important to mankind at the present time, and the most interesting to the student. It gives the earliest clear and definite idea of a land surface on the earth, or rather of the existence of many lands; for they are to be traced here and there from high up in Arctic latitudes to Australia, and from the West of America to Eastern Asia. It offers evidence of the existence, even in those remote days as in the much later miocene age, of astronomical conditions which do not now prevail. It yields proofs of the persistence of a vast lowland flora during extraordinary vicissitudes of the relative level of land and sea, and of the existence of a fauna remarkable for its great fish and amphibia, and whose air breathing mollusca and insecta are of surpassing interest, forshadowing as they do many recent forms. And its study indicates that the movements of the crusts of the earth, which occurred during and terminated the age, were of the grandest kind, and have been of the greatest importance to mankind, destroying, it is true, all the vestiges of a large part of a volume of the earth's history, but bringing coal within the reach of the explorer and miner.

This world-wide formation, usually very thick everywhere, has all the evidences of having lasted during a vast age, and there are present in it the relics of sea floors, of shallow seas and estuaries, of land surfaces, rivers, and marshes. The volcanic activity of the age was great, and is capable of demonstration.

So deep are some of the sediments composing the carboniferous formation in different parts of the world, that the idea of exact contemporaneity is not necessarily much modified. It was in all probability "coal time" universally, and for a long duration. But the beginning of the period was not synchronous in different parts of the earth, neither was the ending. The Devonian age lasted longer in some parts of the earth than in others; and the crust movements which so altered the physical geography of the carboniferous hills, dales, and swamps as to develop a new aspect of nature, terminated the period sooner in some quarters of the globe than in others. In such a locality, however as Eastern Hindostan, the duration of a carboniferous type into the secondary ages is apparent. Hence, in spite of a recognised general contemporaneity, it must be credited that carboniferous, Devonian, Permian, and later deposits were accumulated early and late during the lapse of one great age in distant parts of the globe.

The duration of the carboniferous age in the broadest sense, may be attempted, but with no great success, to be estimated by the time which must have elapsed during the world-wide dispersion of identical species; and its biological relation to the preceding and subsequent formations may be appreciated from the fact that the carboniferous flora, lasting as it did from the bottom to the top of the formation, was foreshadowed in the Devonian, and that it founded the mesozoic. Thus the Australian, Himalayan, British and North and South American marine strata of the carboniferous age contain many identical species of Brachiopoda—the variation from the English types, which were the first described, being very slight. Amongst the corals some forms are equally widely diffused. Now, according to what occurs in nature at the present time, the movements of species from one locality to another by ova, or by wafting of the young—the only method of the lateral or horizontal progress of the brachiopoda—for instance, is impeded by many physical conditions, and is constantly rendered abortive by predaceous and obstructive living forms, and by what is called the strugggle for existence. Migration, or rather the extension of the locality of the species, for the first term implies much more than was or is ever done, is so rarely possible to any great extent under the present complicated natural history and physical condition of the earth that the mind fails to grasp the time which would lapse between the commencement of the dispersive process and the establishment of identical species, even a few thousands of miles off. To bring the subject a little nearer, however, it is necessary to consider that the Arctic and Antarctic cold areas and the frigid bathymetrical ocean zones did not then exist, and that the movements of the crust, producing extension of coast lines, were exceedingly frequent during the age, and must have facilitated the dispersion of littoral and moderately deep sea species.

The dispersion of the species of the numerous cryptogamous plants was doubtless rapid in relation to that of the animals, for their spores could be wafted to a great distance by wind, and they do not appear to have had much to struggle against. With the coniferæ it was different, and the examination of the methods in which fir trees spread in favourable localities, at the present time is very suggestive of exceeding slowness of dispersion. Nevertheless, the cones of the coniferæ were carried here and there by water during the carboniferous age.

To add to the notion of the long duration of the age it must be remembered that a succession of identical floras occurred nearly on the same areas, involving repetitions of growth and of migration.

The growing of the vegetation of each swamp and lowland tract, its accumulation and covering up with sand, shales, and gravel, occupied much time, and the last process involved the destruction of considerable breadths of plant life. The formation of under-clay or warp, if the similar occurrences of the present day be taken as examples, occupied much time, and then a lapse occurred whilst the nearest flora supplied a new vegetation to the virgin soil.

In some instances the recurrence of vegetation was evidently the result of spreading from no great distance; but in others so great a depth of sediment separates the consecutive deposits of coal, and the great subsidence which took place is so evident, that the migration must have been from a considerable distance, and must have occupied commensurate time. In endeavouring to appreciate this lapse of time, it must be remembered that, even on the small surface of the United Kingdom, there was land on some parts during the whole of the carboniferous age notwithstanding the diversity of the deposits and the frequent occurrence of marine conditions.

It would appear that prior to those movements of the earth's

crust which terminated the physical geography of the Devonian age, three elevated tracts of land crossed the kingdom from west to east, and that there were mountainous regions running northwards and north-westwards, including North Wales, Western Ireland, and much of the North Atlantic.

The southern high land barrier passed somewhere in the direction of the Bristol Channel, and then to the east and slightly to the south, having a somewhat definite continuation with the Ardennes. The central barrier, or high land, passed from Shropshire eastwards by Leicester, and then to the coast; and the northern was formed by hills in the present lake district, extending eastwards. On the south of the southern high land, the marine Devonian accumulated in a coral sea, and to the north of it and between it and the central barrier the old red lakes obtained their water supply and sediment from the Welsh hills of the period. North of the central barrier, interrupted lakes and land occurred, and also to the north of the northern barrier. The dry land and the barriers and hills were formed by sub-rocks of Silurian and Cambrian age.

There is no evidence to indicate that the southern barrier was of great height at the end of the Devonian period, but there is some which points out that the first physical change which initiated a new aspect of nature—the carboniferous—was a general subsidence of the region. The coral reefs sank below the bathymetrical zone of the composite forms, and the sea breached the barrier. The southern old red lake began to have its waters impregnated with salt, and its great ganoid fish were replaced by the cestraciont sharks of the age. These left their remains in the bone bed at the base of the lower limestone shales, which are the earliest of the carboniferous series there. The irruption of the sea appears to have taken place to the north of the central barrier also, and the subsidence was great there, a limestone with some sandy strata forming gradually. In the north and north-east, in the present district of the Tweed, deposits collected in shallow water, and vegetation grew which formed the coals at the base of the great Scour limestone.

On the same and on slightly higher horizons are the coals of Fallowfield, Tindal Fell, and Heskett. These are the earliest evidences of the carboniferous vegetation, and it was doubtless in full vigour whilst marine conditions existed to the south.

Probably the high lands constituting the barriers were not covered during the subsidence, which permitted the accumulation of the marine deposits of the carboniferous limestone age. For close to the coal-fields near the central barrier, and which rest on upper Silurian rock, borings here found the remains of carboniferous plants on the palæozoic rock without the intervention of any sediments.

Now the depth of the deposit of limestone about this central barrier is great, and the question arises how was it produced in the immediate proximity of land which was not covered by sea, and which does not appear to have sunk contemporaneously with the sea floor close by? Sinking along definite lines bounded by faults is the only means by which this can be explained; and this suggestion, which was a favourite topic with Phillips, is all the more probable, when it is remembered that the area of accumulation to the north of the barrier was one of vast subsidence during the consecutive ages of the grits and coal measures, whilst there was land still further north. If the stability of one and the instability of the other are not conceded, the original height of the barriers must have been stupendous and beyond example, so far as the size of their bases is concerned.

There are many examples of what I resolved to call in a presidential address before the Geological Society areas of comparative instability and which relate apparently to radial upheaval subsidence along long lines of country where movement has been rare. An instance on the grandest scale is seen in the history of the Himalayas in relation to the peninsula to their south and south-west. For whilst this last area was land during a vast age, that of the Himalayas was repeatedly a marine tract, and suffered subsidences and elevations.

Still further north and beyond the northern barrier, in the Scottish area, carboniferous plants lived a little later, and after a subsidence which permitted the lower calciferous series to accumulate. The lowest coals of the basin of the Clyde are of this age, and the accompanying clay, ironstone, and the fresh water limestones and gigantic fish of Burdie House are all indications of terrestrial conditions. All these evidences of carboniferous vegetation occur in the geological horizon of the carboniferous limestone and Yoredale series.

Never entirely free from sandy impurities the carboniferous limestones north of the central barrier gradually became covered with a thick arenaceous series containing here and there marine fossils and traces of coal plants. These are the Yoredale strata, which consist mainly of the sediments of a somewhat distant north-westerly land, the plants of which were carried to sea by rivers and deposited here and there on the sea floor. It would appear from the evidence collected by the Geological Survey that, after a very considerable thickness of these rocks had collected, either a filling up of the shallow sea or a slight upheaval of the floor occurred, for denudation of their surface happened, considerable depressions and ridges being produced on it. On those spaces and ridges, and indeed on the whole surface of the Yoredale rocks, collected strata which are popularly called the millstone grits, so well seen west of Sheffield. All the depths of this great land wreckage, consisting of silicious and felspathic sandstones and shales, accumulated on a sinking area, some near land and the rest in deeper places. And here and there coal seams are found intercalated, being evidences of the existence of contemporaneous vegetation. Some of them are workable, and others are only valuable as evidences of the existence of the vegetation of the age; many are placed on a hard silicious or ganister bed, but some have an underlying fire-clay. They are very usually covered with deposits containing goniatites and aviculopecten, which doubtless are the remains of marine organisms.

Admitting, therefore, that some of this millstone grit coal may be the result of the drifting and sinking of the vegetation from off lands rather remotely situated, it is still evident, from the existence of the under-clays elsewhere, that some of the grits, by silting up, or by slight upheaval, above sea level, formed the subsoil of swampy ground on which vegetation grew. This approach of the millstone grit sea floor to above sea level was decided enough in the region of the great coal-field around us, for a conglomeratic rock—the rough rock—occupies a somewhat definite horizon on the top of the series.

This rough rock collected in shallow water, and it is important to the geological surveyor, for it formed the base on which the coal measures, proper, rest; and it is suggestive to the physical geologist that a general and wide, but not great, upheaval took place which removed the ocean of the day further off, and which determined a total change in the direction of sediment-depositing currents.

Hitherto the greatest thickness of the sediments of the millstone grit age had been towards the north-west, and the direction of the currents had been from north-west to south-east, but subsequently, as has been suggested from very strong evidence by Sorby, the depositing currents of the next age had no very definite direction. But the carboniferous land of this part of Europe was not yet remote from the sea. Much of it was on the borders of estuaries, and the aspect of nature was probably that of wide flats of grit covered usually by terrestrial vegetation and occasionally overwhelmed by sea. In fact, both practically and theoretically there is much difficulty in separating the mill-grits from the lower coal measures. The lower measures contain some thick and widely-spread sandstones, and the important coal seams, in some instances, rest on a hard ganister bed, and in others on a fire-clay. And to add to the similarity of the deposits of the upper grits and lower coal measures, marine fossils, such as species of goniatites, aviculopecten, and posidonomya, are intercalated above the coals. But the evidences of marine invasion ceased as the deposits accumulated, and more perfect terrestrial conditions arose. The Elland flag-stones, for instance, such prominent features to the west of this town and in the neighbourhood of Halifax, are fresh-water deposits, and are undoubtedly accumulated in an under-clay indicative of terrestrial conditions.

In the region north of the northern barrier successive coal seams and impure limestones and fire-clays occurred during the age of the depositions of the English grits, and then a thick fossiliferous sandstone was followed by the upper coals of Mid-Lothian.

All the minor upheavals and upsiltings of this long age were subordinate to a progressive general subsidence, in which the central and northern barriers were slightly implicated, and this extraordinary crust movement was to continue during the accumulation of over 3,000 feet of coal measures and other deposits, all subaërial in their method of formation, or having collected in shallow water or swampy ground. These products of denudation and of organism succeeded each other time after time; great gravels, shales, and sands were intercalated, and

even traces of some of the rivers of the age are to be found breaching the seams. The more the subject, commonplace as it may be thought, is considered, the more astonishing does it become, for the regularity of the subsidence and its amount must have kept pace with the thickness of the accumulating deposits. That there were many long intervals of quietude in the earth's crust may be gleaned, not only from the thickness of many coal seams, but also from the subaërial denudation which occurred. For instance, high up in the series in this district, is a mass of red sandstone which covers the denuded middle measures beneath; and this red rock of Rotherham, the result of coal measure denudation and removal, accumulated during the early days of the upper coal measures, for it is lower in the geological series than some members of the uppermost coal measures.

Before the close of the age, marine conditions occurred in the rock, and a limestone with goniatites was formed; but still coal seam formation proceeded until a totally different series of crust movements commenced in this country.

The flexures which were produced at the close of the carboniferous age had their long axes east and west; they suffered denudation and on the worn edges of their strata the "used-up carboniferous"—the lower Permian. Elsewhere, resting apparently and often really conformably on the carboniferous strata, the Permians accumulated until great north and south curvatures occurred and produced the Pennine chain.

The denudation of the anticlinal or upward curves of the north and south flexures progressed, and the coal measures, once continuous across England, were worn off along the back-bone of the country and from off the east and west ridges also. Vast as was the destruction and removal, there was still more compensation in nature, for faulting occurred on a large scale, and the measures were in many places sunken down below the level of possible subaërial denudation. It is to the pre- and post-Permian crust movements in producing basins and in uptilting the formerly horizontal seams, and to the subsequent faulting, that we owe the preservation and the possibility of reaching and working much of the coal of this country.

It appears that the position of this town refers quite as much to some remarkable faults, and the results of the post Permian uptilting, as to the presence of the river Don. Two important lines of fault run almost parallel, the one traversing the centre of Sheffield, and the other being to the north of the outcrop of the Silkstone coal. They pass in a north-easterly direction, and the country between them is much broken. Moreover, by a combination of the results of uptilt and faulting, the strike of important coal seams has been so altered that they encircle the town on the south, west, and north. The mineral products have thus been brought within the reach of those by whose industry this town has increased in size and population.

With regard to the lithology of some of the great series just mentioned, it may be suggested that the condition under which the beautiful limestones of the Avon, and the dark, shaly, muddy, calcareous deposits of the corresponding age accumulated in Scotland, were very different. The stone in the southern example is many coloured and is nearly an organic deposit, whilst the shaly strata of the northern series have crowds of calcareous fossils in them. Remove the shaly substance, however, and consider and compare the fossils of both localities, and no satisfactory distinction can be drawn between the depths at which they may have accumulated.

Both deposits contain crinoids, polyzoa, brachiopoda, and simple and compound hydro-corals. The same occur in the limestones to the north of the central barrier, which are intermediate in the arenaceous condition between those just mentioned. It is admitted that the mineral condition of the original deposits has altered, and it is possible that much impurity may have been removed by percolating carbonated waters, from the purest of the limestones. And, indeed, unless this is credited, it is impossible to compare some of these old marine sediments with any now forming on the floor of the sea. All the known calcareous sea floor deposits contain a very considerable percentage of silica and other matters, and if the carboniferous limestones were ever in the condition of modern deep-sea ooze, in order that they should have looked like the chalk they must have lost in some manner or other more than 35 per cent. of impurities. So far as I can understand, much of the carboniferous limestone may have accumulated at no very great depth and on banks within the scour of currents, and their prevalence would account for the comparative absence of sandy sediments in some situations. No traces of atoll formation exist.

With regard to one or two late discoveries relating to the organic remains of the carboniferous limestones, it is necessary to refer you to Moseley's important work amongst the Tabulata. These must now be removed from the true stony corals, and some will be relegated to the Hydrozoa, and others to the Alcyonaria. It is a fact of great interest that Sorby should have noticed that whilst the modern true corals are built up of carbonate of lime in the form of arragonite, the great tabulated forms of old are composed of calcite.

Quite lately Mr. Busk has been investigating the large polyzoa of the genus Heteropora, and I saw, under his manipulation, that this recent and Crag group, with strong palæozoic affinities, is so constructed that the branching tubular organisms of the oldest rocks with perforations in their walls and tabulæ must be included amongst species of genera closely allied to it.

A host of ill-defined tubular forms, such as the Stenoporæ, will thus find a final zoological resting-place.

The arenaceous series of the carboniferous formation in England are not less wonderful than the calcareous. They thin out very rapidly from 10,000 feet in the Burnley district to 100 close to the central barrier in Leicestershire, and it would appear that the sea drift was from the present region of the North Atlantic, along the shores of the swampy coal plant-growing-land.

The arenaceous deposits to the south of the central barrier have the same general relation as those to the north, and the grits of the Welsh and Bristol coal-fields are silicious, and were in all probability derived from the Silurian and old red rocks to their north-west. The culm measures of Somersetshire and Devonshire—those thick deposits with impure thin coals with limestones towards the bases—are of the age of the upper parts of the carboniferous limestones and of the grits of the central area. The evidences in this age of the denudation of granite and other silicious lands, and of more or less distant diffusion of the sediment, extend far and wide from the United Kingdom, a belt of similar rocks being found in south-western and central Europe. It is, moreover, very probable that the upper Vindhyan rocks of Hindostan, those fine sandstones and grits which have yielded the building-stones to the great Gangetic cities, are of the same relative age (or slightly older) as the strata of which so many Yorkshire towns are mainly built.

Whence came the thousands of feet of the sands and shales of the coal measures? is as yet a question which cannot be answered. It appears that very widely distributed deposits of the same kind are comparatively rare amongst them, and that most of the organic deposits, as well as the inorganic sedimentary, do not extend over great breadths, but are more or less lenticular in shape, or thin out or become changed in their lithology. This fact and Sorby's suggestion that the currents which deposited the strata had not any definite course rather tend to the belief in the former presence of a vast delta during that ancient aspect of nature. It is certain that some of the vegetation which subsequently became coal, and many feet of the roof above, were not always formed with great slowness, for stumps and trunks of trees have been found standing where they grew, with their roots in their under-clay and their stems wrapped round with coal, and the shale and gravel above. Moreover, in some places, a series of these interesting relics exists, one set being placed above the others.

With regard to the coal itself, varying as it does in its physical peculiarities, all that has an under-clay grew as vegetation on land. It is at present rather difficult to believe that where a coal-seam is found upon a hard silicious bed without a vestige of clay or of old soil, its plants were rooted there. But the stigmarian roots are not unfrequent in the ganister, and at the present time a peculiar vegetation is growing on the grits to the west of this town with a very small amount of humus intervening. Some coal-seams, especially the cannels, would appear, however, not to have been produced by plants which grew on the rocks beneath, and they are the result of vegetation drifting and becoming water-logged.

In reflecting upon the history of those carboniferous deposits in relation to the subsequent great changes in the physical geography of the earth, the idea that geological histories repeat themselves does not obtain that importance with which it is credited in relation to human events. It is true that there were important triassic, oolitic, wealden, neocomian, and tertiary lands, whose vegetation has been metamorphosed into a kind of coal. But the wonderful depth and the extraordinary vertical

repetition of organic and inorganic deposits, of the carboniferous formation, and the remarkable crust movements which enabled them to accumulate, are without subsequent examples.

In conclusion, I must remind you that the volumes of the "Geological Record" give the literature of the carboniferous formation year by year, and that lately a magnificent contribution to the subject has appeared in the memoirs of the Geological Survey of England and Wales in the form of a great volume on the geology of the Yorkshire coal fields, by Prof. Green, one of our vice-presidents, and Mr. Russell. A very concise and excellent geology of the West Riding has also recently been published by Mr. Davis, who is amongst us to-day, and Mr. Bauermann has contributed a capital article on coal to the "Encyclopædia Britannica."

THE FRENCH ASSOCIATION

Montpellier, Sunday

THE French Association for the Advancement of Science met at Montpellier on August 28. The president this year is M. Bardoux, the late Minister for Public Instruction, who has been succeeded by M. Ferry.

His address was devoted entirely to generalities on the necessity of providing a good education for the young. He did not touch upon the great question which agitates the public mind in France in connection with the Ferry Bill. It may be inferred from the strong encomiums passed on M. Jules Simon, that M. Bardoux must be ranked among the opponents to the Ferry Bill.

M. Laissac, mayor of Montpellier, and M. Cazelle, prefect of the Herault, replied to M. Bardoux. M. Saporta, the general secretary, gave an address summarising the results of the last year's meeting, and M. Georges Masson read a financial statement which showed that the capital of the Society amounts to about 300,000 francs. The subsidies paid for research last year amounted to 10,000 francs.

These addresses being the only ones which were given in the name of the Association, and as the presidents of sections gave no official addresses, it will be quite impossible to have any idea of the opinions of the meeting on the topics of the day.

Although but a small city, Montpellier is famous in the annals of science, and in former years its university was deemed a rival to Paris. But in latter years Montpellier has lost much of its *prestige*, although it had the honour to be the birthplace of Auguste Comte. The growing academy of Toulouse disputes with Montpellier the pre-eminence in south-eastern France. Meanwhile the impending meeting of *savants* at Perpignan on the occasion of the inauguration of Arago's statue at the end of September will throw the Montpellier meeting somewhat into the shade, and deprive it of a number of constant and influential members. The interest of the meeting will consist principally in excursions professing to promote ends of great moment for the welfare of the region, viz., the extinction of phylloxera, the construction of an irrigation canal from the Rhone, the local meteorology and botany, which are strongly represented by M. Charles Martins, a brilliant writer, and the director of the celebrated Montpellier plant-gardens. A specimen of the French Atlantic cable now in course of being placed, will be exhibited and explained by M. Gariel, the general secretary of the Council, and the scheme of the French Company explained for the first time. Experiments will be made on electric lighting and the telephone.

The French scientific caravan, officered by MM. Quatrefages, Mortillet, and Broca, to be sent to the Congress of Anthropology at Moscow, is to arrive in Montpellier before the end of the meeting. M. Bergeron, one of the French *savants*, who was present at the Sheffield meeting, has arrived in order to tell the French Association of what was done by her elder sister.

THE SWISS NATURALISTS

THE sixty-second annual meeting of the Swiss naturalists was opened on July 10 at St. Gall. The attendance was comparatively large, no less than two hundred Swiss and twenty-one foreign *savants* being present. Among the latter we notice Prof. Hébert (Paris), Mr. Forrer (San Francisco), Herr Nördlinger (Stuttgart), Dr. Richthofen, and many others.

On Monday, the 11th, the first public meeting was opened at the Grossrathhaus, before a large audience of visitors and ladies, by Dr. Rechsteiner (St. Gall), who gave an address on the recent progress of science; also pointing out the importance of the neighbourhood of St. Gall for the study of geology, and discussing the variety and importance of chemical processes in the life of nature. A second lecture was given by Prof. C. Vogt (Geneva) on the archæopteryx, the interesting reptile-bird which has provoked so animated a discussion among anatomists, and of which we possess only two specimens—that of the British Museum and that newly discovered at Solenhofen, Germany. According to the first, which was very incomplete, this Jurassic animal was considered as a bird, having a beak, nails, and feathers; while the Solenhofen specimen, quite complete, and of which Prof. Vogt exhibited very good photographs, proves undoubtedly that we have to do with a bird-like reptile of the size of a pigeon, which had both scales and feathers, a beak provided with teeth, armed wings, bird-like feet with nails, and a reptile tail consisting of twenty vertebræ. This discovery gave to Prof. Vogt the occasion to make a brilliant address on the origin of species, the adaptation of organisms to the medium they inhabit, and the way in which this adaptation goes on from the periphery to the centre.

Two other lectures were given by M. Victor Fatio, on the phylloxera, and by M. Raoul Pictet on the synthetical theory of calorific phenomena. The naturalists then went to the traditional breakfast served on paper table-cloths with paper napkins, in the beautiful hall of the Kornhalle, the walls of which are decorated with four pictures, by M. Kirchofer, which represent the country of St. Gall during the periods of the lignite (*Schieferkohle*), of the molasse, of the glacial epoch, and of prehistoric man. At two began the sittings of the sections. In the Section of Physics Prof. Hagenbach opened a very interesting philosophical discussion on "centrifugal force," in which discussion he was followed by Prof. Mousson (Zurich), who made a valuable communication on the structure of solid bodies, and on the molecular phenomena which produce the phenomenon of heat. Prof. Pictet (Geneva) explained his researches into the mechanical theory of heat. On the following day Professors Forel (Morges) and L. Soret (Geneva), the indefatigable students of the oscillations of the level of the Lake of Geneva, gave, in the Section of Physics, very interesting communications on that subject, and especially on the rhythmical oscillations described as *seiches*.—M. Dufour having communicated the results of his measurements on the glacier of the Rhone, according to which the lower extremity of this glacier has receded no less than eighty metres (260 feet) during the last two years, a long discussion on the causes of the oscillations of glaciers was engaged between MM. Dufour, Forel, Mousson, and Hagenbach. Finally we notice in the Section of Physics the communications, by M. H. Dufour, on the diffusion of gases; by Prof. Hagenbach on the forms of hail; and by Prof. Colladon (Geneva) on his theories on the optical properties of ice.

The sixty-third meeting will take place next year at Brieg, in the Valley of the Rhone.

SCIENTIFIC SERIALS

The Journal of Physiology (vol. ii. No. 2, issued July).—On the effect of the respiratory movements on the pulmonary circulation, by H. P. Bowditch and G. M. Garland.—On absorption without circulation, by B. F. Lautenbach.—On protagon, by Arthur Gamgee and Ernst Blankenhorn.—On a few further experiments with pituria, by Sydney Ringer and William Murrell.—On the antagonism between pilocarpine and extract of *Amanita muscaria*, by Sydney Ringer and William Murrell.—On some old and new experiments on the fibrin-ferment, by Arthur Gamgee.—On the effect of two succeeding stimuli upon muscular contraction, by Henry Sewall.—There is added a list of titles of books and papers of physiological interest published since December 31, 1878, to date.

Journal of the Royal Microscopical Society (August).—Transactions.—On a new species of excavating sponge (*Alectona millari*), and on a new species of Raphidothecea (*R. affinis*), by H. J. Carter, F.R.S.—On a new genus and species of foraminifera (*Aphrosina informis*), and on the spicules of an unknown sponge, by H. J. Carter, F.R.S.—On the theory of illuminating apparatus employed with the microscope, by Dr. H. E. Fripp.—Observations on *Notommata Werneckii* and its parasitism in the tubes of Vaucheria, by Prof. Balbiani; translated from the *Annales des Sciences Naturelles* (*Zoologie*), 1878.—The record of current researches relating to invertebrata, cryptogamia, microscopy, &c.

The American Naturalist (August).—Adjectives of colour in Indian languages, by Albert S. Gatschet.—On the habits of a species of tarantula (*T. tigrina*?), by Mrs. Mary Treat.—On the formation of Cape Cod, by Warren Upham.—The geological museum of the School of Mines, Columbia College, by Israël C. Russell.

Kosmos, iii. Heft 3, June; Th. Buy, on the estimating of conflicting authorities, or thoughts on the education of the future.—Dr. Otto Kuntze, how the primitive rocks are built-up.—Dr. Dodel-Port, Infusoria as assisting in the fructification in the Florideæ, being a contribution to our knowledge of the interchange of relations between the plant and animal worlds, with illustrations.—Dr. D. F. Weinland, on the statistics of population in the animal kingdom.—T. H. Becker, on the serpent myth.

THE *Revue Internationale des Sciences* (August) contains the following papers:—On the embryogenous vesicle and on parthenogenesis in animals, by Prof. Balbiani.—On the metaphysics of Claude Bernard, by Ch. Letourneau.—On the history of embryological doctrines, by Prof. Kölliker. This is the recapitulation of a German work by the eminent biologist, recently published in a French translation.—On the reality of our perceptions, by Prof. Helmholtz.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, August 18.—M. Daubrée in the chair.—The following papers were read:—On the meridian observations of the minor planets, made at Greenwich and Paris during the second quarter of 1879, by M. Mouchez.—Mr. J. A. Serret presented to the Academy the eighth volume of the works of Lagrange, entitled "Traité de la Resolution des Equations numériques de tous les Degrés, avec des Notes sur plusieurs Points de la Théorie des Equations algébriques."—M. Milne-Edwards presented the complement of the thirteenth volume of his "Leçons sur la Physiologie et l'Anatomie comparées de l'Homme et des Animaux."—Reply by M. Berthelot to M. Wurtz's observations on hydrate of chloral.—On the phenomena of secreting irritation which are apparent in rabbits under the influence of faradisation of the tympanum, by MM. Vulpian and Journiac.—Table of numbers of invariant derivatives of given order and degree, belonging to the binary form of the second order, by Prof. Sylvester.—Methods of graphic calculus; employment of these methods for the revision of projects bearing on the development of the network of French railways, by M. L. Lalanne.—On irrigations and the sulphide of carbon, by M. Mabègue.—On the submersion of vines as a remedy against phylloxera, by M. Faucon.—M. Davin made a communication on the same subject.—The President then stated to the meeting that M. Janssen had been designated to represent the Academy at the inauguration of the statue of François Arago at Perpignan.—The second volume of the "Correspondance politique de Frédéric le Grand" was presented to the Academy by the Berlin Academy of Sciences.—On the integration of irrationals of the second degree, by M. Alexéeff.—Observations on M. Aoust's note on the movement of a straight line in a plane, by M. Ed. Habich.—On atmospheric waves and the monthly lunar equation, by M. Bouquet de la Grye.—On the scintillation of coal-gas flames, by M. F. A. Forel.—On the absorption of nitric oxide by the proto-salts of iron.—On the reaction of chloride of zinc on normal butylic alcohol, by MM. Le Bel and Greene.—Thermal researches on nitroglycerine, by M. H. Boutmy.—On the tenor of urea in urines, by M. G. Esbach.—On the elimination of bromine from bromocitraconic acid, and on a new organic acid, by M. E. Bourgoin.—On scandium, by M. P. Clève.—On the oxy-acids of sulphur, by M. Maumené.—On the composition of slate, by the same.—Note on a means of preventing inundations, by M. A. Sarrand.—On a peculiarity apparent in Jupiter and its satellites, by M. E. Gand.

August 25.—M. Daubrée in the chair.—The following papers were read:—Discovery of two comets, communicated by M. Mouchez. One was discovered by M. Palisa, of Pola, and the other by M. Hartwig, of Strassburg.—On the digestive ferment of *Carica papaya*, by MM. Wurtz and Bouchut. This strong ferment (*papaïne*) is easily isolated.—Reply to M. Berthelot's observations, by M. Wurtz.—On a process by which may be obtained in any ball-governor, the degree of isochronism desired, and maintaining this degree for all speeds; general theory, by M. Léauté.—On some multiple stars, according to observations made at the Imperial Observatory of Rio de Janeiro, by M. Cruls.—Researches on the compressibility of gases at high pressures, by M. Amagat. All the gases studied, except hydrogen, presented a minimum of the product pv, situated for each gas about the following pressures (expressed in metres of mercury): nitrogen 50 m., oxygen 100, air 65, carbonic oxide 50, formene 120, and ethylene 65. Thus, as might be expected, the gases that are probably nearest the circumstances determining their liquefaction are those which attain the greatest compressibility.—On the maximum tension and the vapour density of alizarine, by M. Troost. The maximum tension is about 11 mm. at 261° and 20 mm. at 276°. The observed density was, in three experiments, 16·32, 15·0, and 17·8. (The formula $C_{28}H_8O_8$ leads to the calculated density 16·62 for 4 vols. The equivalent of alizarine, then, corresponds to 4 vols.).—Purification of hydrogen, by M. Lionet. This may be effected in the cold state. Oxide of copper arrests, in cold, all the combinations of hydrogen which it may contain as impurities, except carbonised hydrogens.—On the active principle of *Ammi visnaga*, by M. Mustapha.—On a new mode of administration of ether, chloroform, or chloral to the sensitive plant; application to determining the velocity of liquids in the organs of this plant, by M. Arloing. The mode is that of presenting the anæsthetic to be absorbed by the roots. Chloral does not act as an anæsthetic on the sensitive plant; the other two have a similar action to that on animals whether they penetrate by the leaves or the roots. The petioles fall suddenly and successively from below upwards as chloroform absorbed by the roots reaches their insertion. Hence the rate of absorption can be easily calculated. The velocity increases from the base to the top and is one and a half times to twice as great in the petioles as in the stem.—Studies on hydrophobia, by M. Galtler. This relates chiefly on its manifestation in the rabbit, to which it may be transmitted, causing paralysis and convulsions. Salicylic acid administered by hypodermic injection daily did not prevent development of the disorder in the rabbit. The saliva of a mad dog, obtained from the living animal and preserved in water, is virulent, in some cases, even twenty-four hours afterwards.—Researches on animal heat, by M. D'Arsonval. Calorimetry should, scientifically, precede thermometry. The author proposes a new calorimetric method, by which the production of heat in animals can be followed during whole days and weeks. The calorimeter is in an inclosure at constant temperature; and it regulates automatically its own temperature, which remains always invariable.—Researches on the *rôle* of nerve fibres contained in the anastomosis between the superior laryngeal nerve and the recurrent laryngeal nerve, by M. François Franck.—On the malacodermic zoantharia of the coast of Marseilles, by M. Jourdan.—Diffusion of copper in primordial rocks and sedimentary deposits proceeding from them; consequences, by M. Dieulafait.—The falling stars of August, 1879, by M. Chapelas.

CONTENTS

THURSDAY, SEPTEMBER 11, 1879

OUR NEW PROTECTORATE

Our New Protectorate, Turkey in Asia; its Geography, Races, Resources, and Government. By J. Carlile McCoan. 2 vols. (London: Chapman and Hall, 1879.)

Narrative of a Journey through Khorassan and on the North-west Frontier of Afghanistan in 1875. By Col. C. M. MacGregor, C.S.I. Bengal Staff Corps. 2 vols. (London: Allen and Co., 1879.)

WHATEVER other interests may have suffered through the late convulsions in the East, those of science, and especially of geography, have at all events been largely benefited. The cession of Cyprus to England and the Anglo-Turkish Convention, which brings a large part of Western Asia within the British political system, could not fail to direct general attention to those regions, thus giving occasion to a number of more or less comprehensive treatises on their physical conditions, natural resources, ethnical, social, and political relations. Of these works, those whose titles are here given, while differing widely in their scope and treatment, are each in its way very favourable specimens. Of the two, that of Mr. McCoan is perhaps on the whole the most satisfactory, as from its purpose and nature it is likely to prove of the greatest permanent interest. Within the compass of two moderately-sized octavo volumes it deals with an immense variety of topics. Yet such is its admirable arrangement, and so thoroughly master is the writer of his subject, that there is nowhere any crowding or confusion, and the result is a most convenient and reliable handbook of "Our New Protectorate." Nothing is omitted that comes fairly within the scope of such a treatise, and a twenty years' personal experience of an intelligent observer of men and things will be sufficient guarantee of the accuracy of his statements, if not always of the justness of his conclusions. In the first volume separate chapters are devoted to each of the five great divisions of Asiatic Turkey, whose orography, hydrography, climate, natural products, present economical conditions, trade routes, political divisions, are treated in detail. These are followed by more comprehensive chapters on the history, races, religions, resources, and government of this eastern section of the empire. The second volume is occupied chiefly with questions of an economical and social character—public works, public instruction, trade centres, agriculture, slavery, polygamy, the Ulema, the capitulations, abuses, necessary reforms.

The chapters on natural resources, products, and agriculture, convey a vivid picture of the inexhaustible latent wealth of these regions.

"On both sides of the Bosphorus Nature has fitted Turkey to be a great agricultural country, but in Asia the geological and climatic conditions of successful husbandry combine in a degree seldom equalled in Europe. Hence nearly every kind of agricultural produce known to commerce may be raised on a scale of abundance limited only by the labour and intelligence employed. The present condition of the country, it need hardly be said, supplies no measure of its full capabilities, but even as it is, the merest bird's-eye glance at its chief products, under all the existing disadvantages of gross fiscal abuses, the most primitive rudeness of culture, and the want of outlets for everything grown beyond the actual needs of local consumption, will show how rich and wide is the field awaiting only better government and a moderate infusion of western skill and capital to become again one of the most productive in the world" (vol. i. p. 203). Nothing, perhaps, gives a better idea of the immense variety of these products, than a glance at the export trade of Smyrna, including, as it does, such varied items as rice, maize, and other cereals, opium, tobacco, silk, and cocoons, valonea, madder, gall nuts, yellow berries, mohair, sponges, besides large quantities of dried figs and raisins of prime quality.

Yet, boundless as they are, these surface-products are represented as scarcely exceeding in importance the vast mineral treasures that lie still almost untouched in the bowels of the earth. "The soil of Anatolia, especially, is largely composed of those earlier rocks which are known to be the most rich in minerals, rocks, in fact, to which some of the most valuable of these are altogether confined. The country is said, indeed, to possess almost every sort of metal except platina. Not only, too, are most of the mineral districts near either the sea or navigable rivers, but—what is even of more importance—the metallic and carboniferous beds are found close to, or within practical distance of, each other. We have thus, in many instances, the proximity of coal and iron which has made the fortune of Staffordshire, and the absence of which in Spain has rendered the rich mines of the Asturias nearly valueless. According to the official records of the Porte, in all some 250 mines of various ores have been discovered throughout the Empire, three-fourths of which are in Asia. Most of these latter were formerly worked, but the great majority have been abandoned through want of capital or for other reasons, leaving only about thirty now at work, and not one of these to the full limit of its producing capacity" (vol. i. p. 209). Detailed accounts are given of some of the more valuable of these deposits, including the famous coal-fields of Erekli, which form part of the Sultan's private domain, but which are so badly worked as to be almost unremunerative.

The rival schemes of railway communication through Turkey with India are briefly but clearly explained, and their merits impartially balanced. In the large map of Turkey in Asia accompanying the work the several routes are laid down, together with the proposed extensions, and all the highways actually completed. In future editions this map might be advantageously supplemented by another, showing the administrative divisions, vilayets, sanjaks, kazas, which are so necessary to a full comprehension of Turkish geography, and which are yet so difficult to procure.

Col. MacGregor's work appears somewhat late in the field, but is none the less welcome as a valuable contribution to our knowledge of a region still but little known, notwithstanding its daily increasing political importance. It is somewhat of the nature of an itinerary, in which the towns, distances, elevations, water and mountain systems, and all other points of interest along the route traversed by the enterprising explorer are carefully described. From the title it might be supposed that the ground thus sur-

veyed was restricted to the provincc of Khorassan. But the whole of the Iranian table-land was actually crossed from Bushire, on the Persian Gulf, through Shiraz and Yezd, in a north-easterly direction, to the Afghan frontier. Here it was the traveller's intention to break fresh ground by penetrating from Herat along the Hari-rud valley, and through Bamian, direct to Kabul. But this scheme, which would have opened up an entirely new region, was thwarted at the outset by two insurmountable difficulties.

The immediate consequence was that instead of an able and much-needed work on the Perso-Afghan highlands, we have one limited mainly to the north-eastern districts of Persia. On this region much additional light is thrown, and an attempt is made to remove the obscurity still attaching to the water-system of the country between the Bakharz and Ghaïn ranges. "The drainage of the space between the northern face of the Doroh hills, the eastern slope of the Ghaïn range, and the southern side of the Khaf range, I believe to be as follows:—First, it does not enter the Hari-rud by the Karat-rud, cutting the Dushakh ridge, as is shown in our maps, nor does it drain to the Harût-rud, or to the Hari-rud direct. All the drainage of this space is absorbed into three great depressions, called 'daks,' that is, the drainage of Nibolûk, of Ghaïn, and of Khaf Païns, goes to the Dak-i-Diwalan; that of the Zirkoh tract, which includes all to the east of the Auguran range, including Gulwarden, Yezdun, and Kaland, drains into the Dak-i-Khurshab, close to the Koh Kabuda; while that of Fûrg, Daramian, Ahwaz, &c., drains to the Dak-i-Tundi, fifteen farsakhs from Ahwaz, and a portion from Mogulbackhe to Pahre runs direct into the Hari-rud. This may seem at first sight a rather startling statement, but it is not so in reality. In the first place, it must be remembered that the process of denudation of the surrounding hills, which is constantly going on, must have a tendency to create the low ridges which cause these depressions; and as there is not sufficient water to keep a way open for itself, and, moreover, the soil is salt, what there is is rapidly evaporated and sucked in, and it is easy to see how these drainage beds have lost the power of discharging themselves to what, no doubt, should be their proper exit, the Hari-rud" (vol. i. p. 204).

Elsewhere some useful information is given regarding the "kavirs," "rîgs," "lûts," and "beyabûns," which occupy such a large portion of the Iranian tableland; but the existence is denied of one continuous "kavir" (salt desert) stretching from Kûm to Bejistûn, though "there are a great number of smaller kavirs due to local drainage"[1] (vol. ii. p. 138). A graphic description is given at p. 101, vol. i., of one of these dreary kavirs twelve miles long on the route between Kûr and Tabaz. "It is rather difficult to suggest anything that will give an English reader an idea of what this kavir is. It is not sand, nor is it in the least like the desolate plains of India, which, burnt up as they may be, are luxuriant in their vegetation compared with kavir. It has, speaking quite literally, not one blade of grass, nor one leaf of any kind, not a living thing of any sort. It is composed of dark soil, which looks as if it had been turned up by the plough a year before, but which is covered with a thick salt efflorescence, which glitters painfully to the eyes. All round, as far as the eye can reach, there is nothing to be seen but this glare of white, which seems to stare piteously on you as you pass by, crunching over its dry crust. Every here and there is a dark patch, which, on getting up to, you find to consist of moist earth which seems, as it were, to have sweated up from beneath. These patches also dry up, and then the salt shows. The surface of the kavir is not smooth, but is so honeycombed with small holes about nine inches deep and the size of a man's head, that it is very difficult walking for animals; but as the soil of the kavir binds very well, a good road could doubtless be made over it."

Altogether, what with kavirs, stony wastes, rough roads, brackish water, filthy serais with little accommodation beyond foul air and noxious vermin, it is not astonishing to learn that the writer did not find travelling in Persia much more pleasant than others have done before him, and it is depressing to hear that there is little prospect ot any improvement in the future. "The worst of this country is that, bad as it is, one cannot conceive how it could be improved in any single way. There is no water, it produces absolutely nothing, and there is no possibility of water being collected for irrigation" (vol. i. p. 84). Worse still, the sands are in many places visibly gaining on the arable land, and even on the inclosed cities themselves. "The country is, in fact, in the process of changing from a series of rocky ridges to one of undulating sandy wastes. Yesterday's march showed the sand triumphant; to-day the rocks are still fighting on. This process of burying is most peculiar, and may be witnessed on a small scale in almost any village between this and Yezd. You see the sand blown against the wall, gradually getting higher and higher, till it blows over and then forms a mound in the field beyond, which gradually increases its height till all trace of wall and field is lost, and you have before you a sand-heap. I can quite believe now the stories of towns being buried, having myself seen the thing on a small scale" (vol. i. p. 147).

In the caravanserai of Bandar Gaz on the Caspian, acquaintance was made with what would appear to be "a new specimen," which may interest entomologists. "It had a head all made up of eyes, a body like an ordinary fly, and a tail like a gimlet. It never made any noise, and it always attacked to the rear, and once it had got its gimlet into you, it seemed to afford it such pleasure that it invariably parted with its life sooner than let go. But its effects were not realised till after death; then came on an itching pain that nearly drove one mad" (vol. ii. p. 166).

In case a second edition should be required of this work, attention may be directed to the peculiar spelling of proper names, with a view to introducing some kind of law and order where all is now sheer chaos. It would probably be too much to hope for a uniform adherence to some scientific or at least intelligent system of transliteration; but a moderate degree of consistency might at least be expected from a writer who has some knowledge of the Arabo-Persian writing system. But here we have neither consistency, nor uniformity, nor anything but the wildest confusion, and the accompanying map at

[1] Originally *kavir*, or rather *kabîr*, was an adjective, simply meaning *great*, the full expression being *Darya-i-kabîr*, "the great ocean," *i.e.*, of salt, and it may be added that, notwithstanding Col. MacGregor's view, the natives invariably apply this expression collectively to the whole of the vast region stretching from the Ghaïn highlands westwards to Yezd and Kashan. Further north this salt waste would seem to intersect the Ghaïn range west and east, here merging with tbe Khaf Desert, which joins the Dashti Na-ummed "desert of despair") on the south, and the Ghorian wastes on the east.

variance with the text, the text with itself. Hence, to quote a few out of innumerable instances, such alternatives as Yezd and Yuzd, Dalaki and Dulukee, Mahamadan and Mahomedan, Geeach and Giach, Tabaz and Tubbuz, Ghain and Ghaeen. Then such old friends as Meshed, Bushire, Turcoman, Hari-rud, disguised as Mushud, Bushuhr, Turkmun, Hurri Rood, without any conceivable advantage. It may be stated that owing to these eccentricities the spelling in the passages here quoted has necessarily been reduced to system.

A. H. KEANE

OUR BOOK SHELF

Catechism of Agricultural Chemistry and Geology. By the late J. F. W. Johnston. An Entirely New Edition, Revised and Enlarged by C. A. Cameron, M.D. Seventy-eighth Thousand. (Edinburgh and London: Blackwoods, 1879.)

THIS popular and useful little book has been decidedly improved by the additions and alterations which Dr. Cameron has made. Since the author's death, about a quarter of a century ago, this catechism had been once revised (in 1863) by Dr. Voelcker, but the time had long since arrived for further changes. If the present editor had been less scrupulous in adhering to the original form and substance of Prof. Johnston's work, this issue would have justly merited the description on the title-page of "An entirely new edition, revised and enlarged." There are, it is true, two fresh pages in the present edition, corresponding to a few new tables of the composition of cattle foods, but we fail to find the numberless small changes and additions which the progress of science demanded. Every sentence of the book should have been rigorously scrutinised and thoroughly amended, or even excised, where necessary. All expressions such as these: "Rancid butter is said to be sweetened" (p. 73), "It is said that if a cow be liberally supplied with whey" (p. 74), "The feeding with whey thickened with meal is said" (p. 74), should be removed. Statements of which the teacher is not sure should not find a place in an elementary catechism. Again, the table, on p. 34, of the ash-constituents removed from an acre by various crops needs emendation. On turning to page 53 we find two other tables showing the produce of corn and straw in certain field experiments with various manures. We do not think the omission of these tables would entail any loss, while their place might be profitably occupied by a series of conclusions deduced from the really satisfactory experiments on crops made at Rothamsted or at some of the continental agricultural stations. For, indeed, what lesson can be learnt from the statement (p. 53) that in an unnamed locality, on an undescribed soil, during a season of which the rainfall and temperature are unrecorded, and by the use of a wheat manure the composition of which is not furnished to the reader, 42 bushels of wheat were produced per acre? Without duplicates and without repetition in different localities and in different seasons, field-trials of manures are positively misleading. But when once such tables as those on pages 34 and 53 have got into a popular work and remained there fifteen years, they have a good chance of remaining fifty.

The statement on p. 67 that parsnips contain no starch will not stand, while we conclude that it was by some oversight that a tabular account of the constituents of various root-crops has been omitted by Dr. Cameron in re-casting and amplifying the data given by Dr. Voelcker in previous editions on page 65. We note here that question 363 on page 63 is repeated in question 374 on page 67, and that the statistics (p. 74) of cheese production in the United Kingdom are no longer correct.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

Palisa's Comet

I INCLOSE an ephemeris of the comet which was discovered at Pola by Herr Palisa on August 21, thinking that it may be of interest to some of your readers.

The ephemeris is calculated from observations made at my observatory on the nights of August 26, 27, and 28, by Dr. R. Copeland and Herr Lohse.

The comet is easily visible in a 4-inch telescope.

Ephemeris of Palisa's Comet

Berlin midnight.	R.A. ☌ h. m.	Decl. ☌ ° ′	Log. Δ.	Log. r.	Brightness.
Sept. 5	11 43·6	+44 47·0	0·2219	0·0393	
6	50·4	44 15·8	·2191	·0362	1·7
7	11 57·2	43 42·7	·2163	·0331	
8	12 3·9	43 7·8	·2137	·0301	
9	10·6	42 31·1	·2112	·0272	
10	17·3	41 52·5	·2088	·0243	1·8
11	23·9	41 12·1	·2065	·0215	
12	30·4	40 30·0	·2043	·0187	
13	36·8	39 46·1	·2023	·0161	
14	43·2	39 0·5	·2004	·0136	2·0
15	49·5	38 13·3	·1987	·0111	
16	12 55·7	37 24·5	·1971	·0087	
17	13 1·8	36 34·2	·1957	·0064	
18	7·8	35 42·4	·1945	·0042	2·1
19	13·7	34 49·2	·1934	·0021	
20	19·5	33 54·8	·1925	0·0001	
21	25·2	32 59·2	·1917	9·9983	
22	30·8	32 2·4	·1911	·9965	2·3
23	36·3	31 4·6	·1907	·9948	
24	41·7	30 5·8	·1905	·9932	
25	47·0	29 6·2	·1904	·9919	
26	52·2	28 5·7	·1906	·9906	2·3
27	13 57·3	27 4·7	·1909	·9895	
28	14 2·3	26 3·0	·1914	·9885	
29	7·1	25 0·8	·1920	·9877	
30	14 11·9	+23 58·2	0·1928	9·9869	2·3

47, Brook Street, September 5 LINDSAY

Insect Swarms

IT may be worth mentioning in connection with Mr. J. Clarke Hawkshaw's interesting account of the wonderful insect-swarm at Trouville, on August 12 and 13, that the two species which composed it were noticed in immense profusion about the same time in the West of England.

On the 13th ult. (which was one of the very few summer days of the season) I was driving with a friend from Exmouth to Budleigh-Salterton, on the South Devon coast, when our attention was attracted by the enormous multitude of insects (moths and butterflies) which were fluttering over the flowery margin of the road. The butterfly was at once recognised as the "Painted Lady;" the moth was not determined, but from its general appearance, its companionship, and all the circumstances of the case, I have no doubt that it was the *Plusia gamma*. The swarm attended us, with little variation in the numbers, throughout almost the whole of our journey (a distance of five miles), and on reaching Budleigh we found *V. cardui* clustering thickly on the flowers in the brilliant little gardens facing the sea.

Along the road the moth was in the greatest profusion, the numbers being frequently so great as to form a perfect *cloud*.

The effect of the quick, restless, irregular movements of the great host, stretching on mile after mile, was very curious. The butterflies were, of course, less plentiful, but still their numbers must have been immense. They seemed to be finely coloured and in very perfect condition.

The direction in which the swarm was travelling was not specially noted; indeed if food was the object sought it might

well be content to linger in the rich and pleasant pasturage in which we encountered it.

I may add that our observations were confined almost entirely to the grassy and flowery borders of the road, and that the swarm which excited our wonder was probably only a single column of a countless host. THOMAS HINCKS

Budleigh-Salterton, September 2

"Rag-Bushes"[1]

A REMARKABLE instance of this custom existed (I am referring to twenty-five years ago) in Ceylon. On the West Coast, on the road between Chilaw and Jaffna, at a place—the name of which, after so many years' absence, I forget—was a vast collection of rag-offerings suspended to the bushes through which the road was cut. It went by the name of "Rag Fair," with those of us who had travelled in that direction: there were miles of it. They were said to be offerings to the goddess "Kali" (who, in the midst of them, had a temple and *well*), to propitiate her and obtain her protection against the dangers of the way, especially those of wild beasts.

Once travelling up that road, my horsekeeper, "Multu," watered my horse at the sacred well. Out rushed the priest, furious with wrath, and cursed Multu with all the vengeance of "Kali," assuring him that he would be eaten by leopards that very night.

Multu, who, I fear, was an atheist after his kind, merely laughed at the offended guardian of the shrine, and pointing to my rifle lying in the hollow of his arm, told him that while the master or himself carried *that*, he did not care a copper "chailly" (a "brass farden," vernacular) for "Kali," the leopards, or himself.

I soothed the irate old humbug by hanging a strip of rag, which I carried in my pocket for gun-cleaning, on a branch, but especially with a trifling bit of silver—I believe this latter portion of an offering is usually, with miracle- and charm-makers, the most efficacious—and went my way.

Multu had his triumph that night. A wretched coolie travelling along the road—one of the class that supply the chief abundance of the rags—after hanging up his offering and doing "pooja," was, while sleeping in the "maddam," or porch of the temple, of his protecting goddess, actually seized and carried off by a leopard. He was rescued—how, I forget—and brought to the "Rest-house" where I was, but was so dreadfully lacerated about the hips and lower portion of the body that he died in a few hours. E. LAYARD

British Consulate, Noumea, July 5

Signalling by Sunshine[2]

THOUGH I fear by the time this reaches you the subject will have been exhausted, I send you this "note;" you can but throw it into the paper-basket if not wanted.

While at the Cape of Good Hope, my dear old friend Sir Thomas Maclear, then Astronomer-Royal, told me that while measuring the arc of the meridian to verify Lacaille's work, he signalled with the heliostat enormous distances, the clear atmosphere of the Cape being eminently adapted for the purpose. If my memory does not play me false, I think he said one station in connection with his cairn on the top of Table Mountain (3,800 feet) was ninety-five miles distant.[3]

His means of directing the flash was as follows:—A tiny hole is scratched in the quicksilver in the centre of the heliostat, and a board with a larger hole is planted in front of the station, some few feet from the instrument.

The corresponding station is brought in view through the two holes, and all three are consequently "in line." The flash is then directed through the hole in the board, and is thus sent straight to the desired point. Of course telescopes were used for long distances.

Another old friend, Admiral Trotter, used to converse from Admiralty House, Simon's Bay, with friends staying at "Kalk" Bay, some eight or nine miles distant. E. L. LAYARD

British Consulate, Noumea, July 4

[1] NATURE, vol. xx. p. 595. [2] NATURE, vol. xx. p. 508.

[3] An amusing coincidence may be noted here. I was returning from Graham's Town by a steamer, and when we came in sight of the old mountain, I happened to mention Sir Thomas's signalling. My hearers on board jeered at the possibility of making signals with "a piece of looking-glass," when suddenly we were half blinded by a flash of light from the top of the mountain. "What on earth is that?" was the general exclamation! "Only Sir Thomas signalling," was my triumphant reply, "Perhaps you will some of you now believe in a 'bit of looking-glass.'" Sir Thomas' son had, for fun, sent a flash or two down to the steamer.

Bag-like Fabrication exhibited by Sir Sydney Saunders

As much the "production of a large species of spider in Fiji" as a lady's silk dress is the "production" of a worm in China!

A large spider, of a genus common all over Polynesia, and here also in New Caledonia (where formerly much eaten by the aborigines) produces a very strong, thick web. On Sundays generally, when no work is going on in the plantations, the imported Pacific Islanders amuse themselves by wandering about the bush, armed with a frame-work of cane in the shape of an elongated cone, affixed to a long stick. This they twist and twist, round and round in the spiders' webs, till it is coated, sometimes half an inch thick, with the viscous fabric. They then untie the fastenings and draw out the strips of cane, when the bag becomes like a long night-cap (old pattern). I have one before me now, over a yard long, a foot across, and pretty thick, which does not weigh one ounce! It is yellow; the New Caledonian ones are usually grey. I do not think the Fijian natives had the custom originally. Some of the New Caledonian are stretched tight enough to resemble an Indian suspension "tom-tom," and really emit a slight sound on being "tapped." This will give some idea of the strength of the thread, for which see also *The Field* ("My Trip to Lifu"), wherein I notice the impromptu butterfly nets made by some boys stretching the web of this spider across the loop of a bent twig. E. L. LAYARD

British Consulate, Noumea, July 5

Observations on a Wind-Whirl

WHILE making magnetic determinations at Schell City, Mo., a wind-whirl of some violence passed near our tent, moving with the characteristic swaying and halting motions of the tornado. Its base was quite pointed, and about two feet in diameter.

Unlike those seen last year, and described in NATURE about a year ago, there were no surface-winds strong enough to bear dust along the suface of the ground, but the dust carried up in the vortex was collected only at the vertex of the whirl. The dust column was about 200 feet high, and perhaps 30 or 40 feet feet in diameter at the top. The direction of rotation was the same as that of storms in the northern hemisphere. Leaving the road, the whirl passed out on the prairie, immediately filling the air with hay, which was carried up in somewhat wider spirals, the diameter of the cone thus filled with hay being about 150 feet at the top. It was then observed, also, that the dust column was *hollow*. Standing nearly under it, the bottom of the dust column appeared like an annulus of dust surrounding a circular area of perfectly clear air. This area grew larger as the dust was raised higher, being about 15 or 20 feet wide when it was last observed. This whirl could be observed half a mile, finally disappearing over a hill.

This observation, in connection with the one given by me a year ago, has a very important bearing on the theory of "waterspouts" and tornadoes. FRANCIS E. NIPHER

St. Louis, Mo.

Transportation of Seeds

IN a recent number of NATURE which has lately reached my hands, I observe a letter from Consul Layard on the above subject, to which let this note be an addendum.

In my daily expeditions I am exceedingly troubled by the seeds of the *Andropogon acicularis* (Retz), not only adhering on the slightest touch to my clothes, especially to my trousers and socks, to the daily annoyance and occupation of much of the time of my servant in their obstinate removal, but even penetrating my limbs and adhering there to my great discomfort, for the itching that they cause is sometimes intolerable; and my limbs consequently present somewhat the appearance of those of a scarlet-fever patient. HENRY O. FORBES

Kesala, Bantam, Java, July

Shark's Teeth

I WOULD draw attention to the operation of the teeth of the shark on the seizure of its prey. I recollect in Nicholson's "Zoology," a statement to the following effect: "The sharks have teeth arranged in several rows, of which only the outermost is employed, the other rows seeming to replace the outermost when worn out." In a recent visit to the Cocos Islands I had many opportunities of observing these animals in the use of their formidable weapons. In the act of seizure the whole jaw is protruded to a distance (varying according to the size of the fish) of several inches, the innermost teeth coming into position erect

or semi-erect, but as far as I could observe nearly *all* the teeth came into play. When on fishing excursions in the lagoon, the sharks which constantly carried off the bait, were often caught, and in order to extract the hook, a large log, constantly carried in the boats for this purpose, was threateningly presented to its face, and of course instantly seized and held on to for as long as it took to perform the operation of extraction. If, when the fish is quite recently dead, pressure be made on the angle of the jaw, it is easy to observe the action of the rows of teeth.

Kesala, Bantam, Java, July HENRY O. FORBES

A Lunar Rainbow

LAST evening, September 3, at 10.40, a lunar rainbow was visible at Llanfairfechan, in a north-west direction. The arc was continuous, and of a brilliant white light. It appeared to stretch across Anglesey from Beaumaris to Puffin Island. The bow did not last more than 2′ from the time it was first observed by us. F. E. KITCHENER

Llanfairfechan, September 4

A Habit of Cattle

IN the colony of Natal the cattle have an extraordinary liking for bones. They will stand for hours with a bone in the mouth quietly munching, sucking, or perhaps more correctly speaking, levigating the bone with the tongue. I have not heard that cattle have the same habit in the other colonies of South Africa, but I have been told that cattle exhibit the same taste in some parts of South Australia.

In Natal there is, I believe, a scarcity of chalk and limestone in the geological formation. Will this fact account for the habit? Do the cattle lick bones in search of lime?

Can any of your readers account for this strange taste in cattle?

I may mention that horses and other herbivorous animals in Natal do not exhibit the same taste. H. C. DONOVAN

Delagoa Bay, July 20

THE AUGUST PERSEIDS

THIS remarkable meteor shower recurring annually on August 10 is looked for every year with increasing diligence. To Quetelet belongs the credit of having first (in 1835) ascertained the epoch of its maximum display, though the month of August had long been known as one in which there was an abundance of falling stars. As early as 1762 Muschenbroek, in his work on "Natural Philosophy," stated that, according to his own observations, there were more shooting stars in August than at any other period of the year, and his remark is perfectly true applied to the first half of that month, though it is questionable whether the last half of August will bear comparison with that of July, when meteors fall very plentifully, and constitute a periodical display of special note on the 27th–31st. Since Quetelet determined the date of the Perseids, they have been expected every year with great interest, and from the time that Heis first began systematically to register the paths of meteors (nearly half a century ago) to the present day, observers have continued to record the successive apparitions of this prominent star-shower, so that multitudes of its meteors are now accumulated in the catalogues of British and foreign astronomers.

These Perseids appear to have belonged to our system at a very remote epoch, and to have been observed in considerable intensity as far back as the ninth century of our era. They form a continuous ring or zone of particles. The stream may vary in richness, that is to say, the particles may be very unequally distributed along the orbit, but it seems unbroken and manifests itself every year with more or less intensity from its accustomed point, yielding many bright meteors of great swiftness, and almost invariably accompanied by phosphorescent streaks. It was from careful observations of the Perseids that Schiaparelli, in 1866, was led to his theory of the connection or identity of comets and meteors, and the first orbital coincidence found was that of the Perseids with Comet III. 1862, which seems to have been merely the nucleus or condensation of the particles forming this remarkable meteor system.

The annual returns of this shower as observed and described by various observers, when compared together, show that in certain years the display is exceptionally brilliant; in others it is far less imposing. Eduard Heis, at Münster, counted 155 meteors per hour on August 10, 1863, yet on the same night in 1867 the figures had fallen to 24 per hour. He gives the following as the horary numbers derived from observations between 10h. and 12h. at several stations in Germany on August 10 in different years:—

Year.	Station.	Hourly number.	Year.	Station.	Hourly number.
1841	Aachen	47	1863	Münster	155
1842	Aachen	60	1863	Gaesdonck	215
1847	Aachen	55	1863	Peckeloh	109
1850	Aachen	37	1864	Gaesdonck	106
1852	Münster	89	1864	Rom	63
1853	Münster	56	1867	Münster	24
1858	Münster	88	1867	Peckeloh	39
1861	Münster	78	1867	Papenburg	44
1861	Gaesdonck	102	1871	Peckeloh	93
1861	Peckeloh	102	1872	Rom	64
1861	Rom	89	1874	Rom	110

Maximum in 1863, minimum in 1867 and 1850. There were also many Perseids in 1839, when Heis counted 160 per hour. The displays of 1863 and 1871 were of considerable intensity. On August 10, 1863, 9h. to 13¼h., Heis, assisted by several other observers at Münster, registered the paths of 602 shooting stars, and at Gaesdonck on the same night, 563 were recorded between 9h. 17m. and 12h. 9m. It may be mentioned as a curious anomaly, showing how much "personal equation" may have to do with the estimation of meteor magnitudes, that at the two stations referred to, the meteors were classified as follows:—

	1st mag.	2nd mag.	3–6 mag.	Number with streaks.	Total meteors.
Münster	224	226	151	300	601
Gaesdonck	37	84	442	158	563

The Münster observers evidently overrated the magnitudes to an enormous degree.

The display of 1871, though less decided than in 1863, was still a very rich return of these meteors. On August 10 in that year, Signor Bassani, at Cosenza, in Italy, assisted by Signor Scrivani, counted 674 meteors from 9h. to 16h., and at Boston, Mass., Messrs. Sawyer and Stephens, watching the sky from 10h. to 15h. on the same night, recorded 567 meteors. Since that year the displays have not been of special brilliancy, though on August 10, 1874, 281 meteors were counted at Bristol by the writer in a watch of four hours, from 10.45, to 14.45, and on August 10, 1877, 354 meteors were seen in the five hours, from 9.30 to 14.30, giving an hourly number (for one observer) in both years of about seventy.

Dr. Phipson suggested[1] it was to be inferred from the observations that a maximum occurred at intervals of eight years. There had been considerable showers in 1839, 1847, and 1863, and he pointed out that a similar manifestation was due in 1871. In that year we had, as already described, an unusually numerous return of these meteors, and if the suspected periodicity held good, there would be another rich shower in 1879. Perhaps on that account the Perseids of the present year were anticipated with a little more than ordinary interest, but the night of August 10 was generally overcast in England (though at several stations a few meteors were discerned through breaks in the clouds), and thus the chief display has escaped us, though we may yet receive favourable reports

[1] See his "Meteors, Aerolites, and Falling Stars," p. 159.

from foreign observatories. The nights of August 9 and 11 were partly clear, and a few observations were obtained. Mr. H. Corder, in Essex, saw 166 meteors on the 11th, between 9.30 and 15.30, and found the radiant point very distinct at $45° + 57°$. On August 4 a few meteors were seen from one of the earlier radiants at $33° + 51°$, and on the 6th from another at $36° + 58°$. On the 9th he watched from 9h. 30m. until 13h. seeing only 33 meteors (23 Perseids), but the moon was up and there were a few clouds. On the 10th it was cloudy except between 12-12.30, but a few meteors were seen later, in all 21, 18 being Perseids. The horary number cannot have been much over 30. On the 12th in 2h. he recorded 22 meteors (14 Perseids). Two fine meteors were seen on the 10th, the first, at 12.25, gave a vivid flash low down in Cetus, but only the streak was well seen. It was one of those instantaneous meteors often seen amongst the Perseids. Another was noted earlier (at 10.30) in Ursa = Sirius, and leaving a fine streak.

At Welling, in Kent, 50 meteors were counted by two observers from 10.15 to 11.15.

At Debenham, Suffolk, on August 10, 12 meteors were seen between 10.30 and 11.5, but the sky was much clouded. On the 11th, 10 to 11.30, 95 were recorded by one observer. These figures indicate a somewhat numerous return of the Perseids on August 11. The radiant point was deduced as at $46\frac{1}{4} + 57\frac{1}{2}$.

At Blackheath, S.E., Major Tupman found the normal radiant at $45° + 56°$ on August 11, and describes the Perseids as a poor display between 10.15 and 12.

At Bristol, on August 9, 33 meteors were seen by the writer between 9.30 and 12, but there was much interference from clouds. On August 11 20 meteors were noted in the half-hour preceding 10.10, and 15 of these were Perseids. Radiant point fairly well defined at $46° + 58°$.

It will be seen that the four determinations of the radiant here given almost coincide at $45\frac{1}{2}° + 57°$, and prove the meteors to have exhibited an exact and distinctly marked centre of divergence this year. Mr. Greg's average position for the Perseids, derived from a large number of former observations, is at $44° + 56°$, and the writer found, in 1874, 1876, and 1877, a sharply defined radiant at $43° + 58°$, but has more recently detected the existence of two other simultaneous showers from χ and γ Persei.

Signor Denza reports (*Gazetta Piemontese*, August 27 and 28) that a total of 1,155 shooting stars were observed on the nights of August 9-12 at seven Italian stations, chiefly at Volpeglino, by Signor Maggi and his assistants. The greatest number were recorded on August 11. The Italian observers also succeeded in registering 295 meteors on twelve nights in July.

The apparent diffusion of the Perseid radiant point, often noticed by observers, is explained by the activity of many concomitant showers. Observations of the paths much foreshortened and close to the centres upon which they converge are the best to rely upon in getting accurate radiants. The vast number of simultaneous or contemporary systems in operation is shown by a discussion of a portion of the mass of observations which have been collected on the night of August 10. There are certainly more than 60 distinct meteor streams visible on that single night alone, and evidence of many others whose feebleness allows them to elude discovery. The extreme tenuity of some showers is such that no indication of their existence may be detected in a persistent watch of several hours' duration.

The true Perseids are characterised by the swiftness of their flights (the theoretical parabolic velocity being 38 miles per second) and by the bright and often enduring streaks left in their courses. They are sometimes very brilliant, ending in green flashes of remarkable lustre, and the luminous wands they leave behind guide the eye unerringly back to the point of space whence they are directed. They may be most favourably seen in the morning hours, when the radiant has attained considerable altitude; and the observer should take up a position commanding an uninterrupted view of the north-eastern constellations.

The limits of duration of this shower have not been definitely ascertained, but very few Perseids are visible before August 5 or after August 15. It is certain that they open as early as August 5, because Heis, in 1864, saw a stationary meteor on that date, as brilliant as Venus, exactly in the radiant point at $44° + 57°$. None of the real Perseids are visible as late as August 21, 22, or 23, for of many shooting-stars seen on those dates this year, not one could be certainly attributed to that stream. It was formerly considered probable that the shower began at the end of July, but from the paths of hundreds of meteors recorded by the writer at Bristol during this epoch, there is little if any indication of the true Perseid radiant point. There is, however, a very rich display of swift streak-leaving meteors from a point below χ Persei, or more exactly at $32° + 53°$, with which the old Perseids have been confounded, and given that shower an apparent duration far beyond the actual limits.

In addition to August 10 there are other nights in that month when shooting-stars should be looked for and their horary numbers and radiants ascertained. Large meteors have been recorded in exceptional frequency on the 19th-20th and 22nd, and a series of three fine nights, occurring consecutively this year, on August 21, 22, and 23, enabled the writer to obtain observations as follows:—

Date, 1879.	Time. h. m. h. m.	Duration, hours.	Meteors seen.	Sky.
Aug. 21 ...	9 30–13 30 ...	4 ...	68	Clear; stars very brilliant.
,, 22 ...	9 0–15 15 ...	$6\frac{1}{4}$ ...	70 ...	Partly cloudy.
,, 23 ...	9 15–15 0 ...	$5\frac{3}{4}$ ...	73	Clear; clouds at 15h.
Aug. 21-23...	9 0–15 15 ...	16 ...	211	

Not many large meteors were observed, but three of them were as bright as Jupiter. On the night of August 22 there was slight interruption from clouds, and the watch sustained for $6\frac{1}{4}$ hours under such conditions was not equivalent to more than about 5 hours of clear sky. Of the 211 meteors seen, no less than 52 belonged to a splendidly well defined and rich shower of Draconids from a point at $291° + 60°$, which thus apparently constitutes a special display at this epoch, and one of far more than ordinary importance. On August 21, 21 of its meteors were seen; on August 22, 11; and on August 23, 20. They are slow-moving, bright meteors, sometimes trained, and almost invariably with short paths. The maximum occurred on August 21, when in $\frac{3}{4}$ hour before 10.15, 9 of the meteors were traced, though, singularly enough, during the next hour the radiant gave no visible sign. It is not a new system, for the same shower has been seen by many observers, and is No. 78 of Mr. Greg's Catalogue of radiant points (1876), in which the centre is given at $282 + 60$ (12 obs.), and the duration from June 28 to August 25 (?). Major Tupman detected it in 1871, on August 20-25, at $280° + 58°$, and Corder, in 1877, saw 11 meteors from $307° + 65°$, on August 17, which may have been another manifestation of the same stream. In future years these Draconids should be anticipated as a rich and interesting periodical display. Though none of the true Perseids were visible on August 21-23 this year, there was a moderately strong shower near α Persei, at $46° + 47°$, giving bright, swift meteors, with streaks, and other radiant points were indicated in Perseus at $61° + 50°$ and $62° + 35°$, but no shower derived from the 211 meteors seen on August 21-23, would bear any comparison to that of the Draconids referred to.

The night of August 24 was overcast, but on August 25, before midnight, 14 meteors were seen through openings in the storm-clouds. There were four Draconids, two of

which were brilliant. One was observed in the twilight and moonlight at 8.30 falling vertically in Delphinus, and the other, at 9.57, was as bright as Venus, and gave a succession of three outbursts. Path from 79° + 76° to 89° + 67°. There was a vivid flash at the end point which many persons who did not see the meteor itself mistook for lightning. W. F. DENNING

OUR ASTRONOMICAL COLUMN

BIELA'S COMET.—In the actual uncertainty with regard to the present condition of Biela's comet, the importance of an exhaustive survey of the eastern sky during the dark mornings, *i.e.*, the moonless mornings, of September and October, can hardly be exaggerated. The comet may possibly have been so disintegrated by this time that nothing further will be seen of it as such, but there must remain very great doubt as to such being the case. According to M. Otto Struve's observations of the two heads in 1852, their diameters were still considerable, that of A being upwards of 20,000 miles, and of B 37,000 miles, and the brightness of the latter was equal to that of a star of Argelander's ninth magnitude.

With respect to the most promising plan of search, not much, perhaps, can be said, but if a number of observers are available, as it is to be hoped there may be, sweeps in zones of declination between pretty wide limits of right ascension, appear likely to insure some justifiable conclusion as to the comet's present state or position. Prof. Winnecke, we believe, is in possession of a 6-inch refractor, mounted as an "Airy's orbit-sweeper," and if the comet, or what remains of it, be still moving in the old orbit, this instrument, in such hands, will be of the utmost value in the examination of the proper sweeping-lines for the particular dates. But if the orbit has been sensibly changed by further perturbation, the effect of which is wholly unknown to us, the necessary survey of the heavens will be, of course, only partially effected by this means, so that our only resource appears to be, as we have suggested, in a well-organised scrutiny of that portion of the sky wherein it is possible the comet might be situated, and there is yet time to provide for this, if arrangements have not been already made at those observatories which are occupied with cometary observations. To indicate the portion of the heavens in question, we subjoin the comet's places for the dates of new moon in September and October, according to different assumptions as to its distance from the perihelion, with similar places for five days subsequently:—

Days from perihelion.	September 15·5 R.A.	Decl.	Dist.	September 20·5 R.A.	Decl.	Dist.
	°	°		°	°	
0	144·3	+ 9·3	1·60	146·8	+ 8·3	1·56
−10	137·5	12·6	1·47	140·0	11·7	1·41
−20	130·1	16·3	1·33	132·7	15·5	1·27
−30	122·0	20·1	1·20	124·5	19·6	1·13
−40	112·8	24·2	1·08	115·1	24·0	1·00
−50	102·2	+28·2	0·98	103·8	+28·6	0·90
	October 15·5			October 20·5		
+20	170·5	− 3·2	1·65	172·9	− 4·4	1·60
+10	165·1	− 0·6	1·47	167·5	− 1·8	1·42
0	159·2	+ 2·5	1·29	161·7	+ 1·2	1·23
−10	152·8	6·2	1·11	155·3	4·9	1·04
−20	145·5	10·7	0·92	148·1	9·5	0·85
−30	136·7	+16·5	0·75	139·0	+15·8	0·67

THE CLUSTER ABOUT κ CRUCIS.—In a communication to the Paris Academy of Sciences on August 25, M. Cruls, Director of the Observatory at Rio Janeiro, states that on comparing the present appearance of the stellar cluster about κ Crucis, with the map and observations made by Sir John Herschel, he finds notable changes—confirmed by detailed micrometrical measures which he intends to publish. Three double stars are found to be certainly in orbital motion, and there is a rectilinear displacement of the star near the red one. M. Cruls also mentions that he has registered a star 6·5m., which he believes has not been previously remarked, and which he suggests may be variable; it follows B.A.C. 4308 = Lacaille 5293 by 1m. 4·26s., and is south of it, 4′ 14″·6; according to Mr. Stone's position of this star for 1875·0, the place of M. Cruls' object for the same year is in R.A. 12h. 44m. 58·52s., N.P.D. 149° 43′ 11″·0. We notice that the differences given by him are almost precisely the same as the differences between Lacaille 5288 and 5293, though that in declination appears to be in the wrong direction; thus, Mr. Stone's catalogue of 1875 makes the position of 5293 with reference to 5288, in R.A. + 1m. 4·72s., in Decl. + 4′ 10″·4. Is it possible that there can be any confusion here? Mr. Stone has not observed a star in M. Cruls' place.

This cluster is *h.* 3435, and Sir John Herschel's micrometrical details relative to 110 of its components, will be found at p. 17 of his Cape volume; it is remarkable for the various colours of the stars, an attempt to illustrate which is made in the last edition of Chambers's "Descriptive Astronomy."

GEOGRAPHICAL NOTES

THE news of the arrival of Prof. Nordenskjöld at Yokohama on the evening of September 2, will have been received with satisfaction by the whole civilised world. The long-looked for solution of the problem of the North-East Passage has thus been practically accomplished. After being imprisoned in the ice near the Tshuctshe settlement for 264 days, viz., from September 28, 1878, until July 18 last, the *Vega* was at last released, and passing the East Cape, Behring's Strait, on July 20, entered St. Lawrence Bay, which may be said to form part of the Pacific Ocean. Crossing to Port Clarence on the American coast, a short stay was made there, and then the Professor re-crossed to Komian, while all the time dredging operations were carefully made, the formation of the sea-bottom at this spot being particularly interesting on account of the meeting of currents from the Arctic and Pacific oceans. No doubt the *Vega* will bring home a rich collection of specimens. The voyage was then continued, and after touching at St. Lawrence Island, Prof. Nordenskjöld visited Behring's Island, off the east coast of Kamtchatka, where he received the first news from Europe through the resident agent of the Alaska Trading Company. It was here that the professor discovered the fossil remains of the gigantic marine animal *Rhytina stelleri*.[1] On August 19 he left the island and continued his journey towards Japan. On the 31st the ship encountered a severe gale, during which the maintop was struck by lightning, which also slightly injured several of the crew. Without further accident the *Vega* anchored at Yokohama at 10.30 P.M. on the 2nd inst., where she will remain for a fortnight. No deaths took place on board since the vessel left Sweden last summer, and thus the high-minded liberality of Herr Dickson, of Gothenburg, who supplied the means for the spirited enterprise of Prof. Nordenskjöld, is by the complete success of the latter deservedly rewarded.

In the August number of Petermann's *Mittheilungen* the narrative of journeys and voyages to Siberia is continued, with a map showing the most recent voyages through the Kara Sea. A special map has also been issued in which a portion of the course of Nordenskjöld in the *Vega* is laid down. The new coast-line of North-East Siberia is also laid down from the data supplied

[1] This animal was a species of Sirenia, and was exterminated by man within a comparatively recent period. It was discovered about the middle of last century upon the island in question, which has its name from the celebrated traveller who was wrecked there in November, 1741, and who found the place inhabited by large numbers of these enormous animals. They were first described by Herr Steller, who was one of Behring's party. The discovery, however, seems to have been fatal to Rhytina, none having been seen later than the year 1768.

by the Italian naval officer, Lieut. Bove. *Apropos* of recent troubles between Chili and Bolivia is an article, with map, on the desert of Atacama. Among the information in the *Monatsbericht* are a number of important data as to the heights of various places in Japan.

AT the last annual meeting of the Swiss Alpine Club the following resolutions were adopted:—(1) The club determines for six years the field of its excursions as follows:—The high Alps between the cantons of Berne and Valais to be explored from west to east in three parts: the Lenk with its neighbourhood, the Blumlis-alp, and the glacier of Aletsch and the Jungfrau as far as Grindelwald; (2) A series of lectures will be opened for the guides; (3) The central committee will publish all interesting documents collected until now as to the motion of glaciers, with bibliographical notes on former publications on this subject.

THE new number of the Geographical Society's monthly periodical contains Mr. Keith Johnston's "Notes of a Trip from Zanzibar to Usambara, in February and March, 1879," illustrated by an excellent little map, which has been reduced from the original drawing sent home by him. These and the other reports and maps connected with his preliminary work, and published in a previous number, were, as the editor very truly remarks, "a sure promise of great things to come when he should have traversed the unknown regions of the interior," and show very clearly how great a loss geography has sustained by Mr. Johnston's premature death. Notes on the geology of Usambara, collected during the same journey, are by Mr. J. Thomson, the geologist and naturalist of the East African expedition, who has now taken Mr. Johnston's place. The "Lecture on the Origin of the Flora of the European Alps," by Mr. John Ball, F.R.S., occupies a considerable portion of the present number. The geographical notes do not this month contain anything very striking, but some of them are good, especially those relating to Col. Grodekof's and M. Oshanin's expeditions, and to the exploration of the Sanpo River and Count Szechenyi's further attempt to reach Lob-Nor from China. We would also call particular attention to the obituary notice of Mr. Keith Johnston. The rest of the number is chiefly occupied with the presidential address in the Geographical Section of the British Association.

A PROPOSAL similar to the often-ventilated plans of a sea in the great Sahara has been recently made by the Governor of the State of Arizona, in North America. It is suggested that a short canal should be constructed which would admit the waters of the Pacific to a large and low-lying area of land situated between Arizona and Southern California. The district is quite a desert at present, and is believed to be the bed of an ancient lake. It measures some 200 miles in length and 50 miles in breadth; its level is estimated to be about 300 feet below that of the Pacific. Its western boundary is at only 45 miles distance from the Gulf of California, and as on this part, where the canal would have to be built, there is already a lake of 20 miles length, the length of the actual canal would be reduced to 25 miles. The cost of the undertaking would amount to about 200,000*l*., and the work could be completed in six months. The importance of an undertaking of this kind need not be pointed out.

WE learn by telegram from New York that Commander Lull, U.S.N., has read a paper before the American Science Association, on his recent explorations in connection with the proposed ship-canal through the Panama Isthmus. He considers that the only practicable routes are those *viâ* Nicaragua and Panama, and that locks will be indispensable. Commander Lull gives a decided preference to the Nicaragua route.

THE last number of the *Isvestia* of the Russian Geographical Society contains much interesting information as to the meetings of the Society and of its sections. Unhappily, all the proceedings are very old, as we do not find anything more recent than from February 6 to May 30 of last year. It is a pity that the Society does not publish its interesting proceedings immediately after the meetings.

M. HOEVERT has undertaken a valuable work, the compilation of a complete bibliography of all works relative to the geography of Russia published till now. He has already finished the revision of the libraries of the Geographical Society of the Academy of Sciences (which receives *all* Russian works published), and of the General Staff.

WITH a view to turning the island to profitable account, a Saghalien Fishing Association has been established under licence from the authorities at St. Petersburg, and vessels for the purpose are being built or chartered in Japan. The business is expected to prove a very lucrative one.

THE caravan of Capt. S. Martini, whilst on its way to convey supplies to the Italian African expedition, has been attacked by the Somalis tribe and robbed of all its merchandise at a distance of some six day's march from Zeila.

NOTES

THE eighth general meeting of the German Astronomical Society took place at the lecture hall of the Royal Academy of Sciences at Berlin on the 5th inst., under the presidency of Prof. Krüger, Director of the Gotha Observatory. Numerous guests from England, France, Belgium, Holland, Russia, Sweden, Denmark, and Austria were present. The Minister for Public Instruction, Herr von Puttkammer, welcomed the assembly in the name of the German Government. We shall refer to the meeting in a future number.

A SMART shock of earthquake was felt in the neighbourhood of Szegedin (Hungary) on September 3.

AN announcement made by the Society of Arts states that the Society offers the Fothergill gold medal for the best means of protecting ships from loss by fire and by sinking, and a silver medal for the protection of ships from either calamity.

A PAMPHLET containing a collection of necrological notices of the late M. Victor Masson, formerly principal of the eminent Paris publishing firm, has recently been published in Paris. The deceased died at his country house of Chassagne (Côte d'Or) on May 3 last, at the age of seventy-two years. His name was well-known in all scientific circles, as he held the highest place among scientific publishers of the French capital. Personally he was greatly esteemed by all who knew him, his relations with men of science were ever of the most liberal, friendly, and upright character, and the care and elegance with which he brought out the scientific works entrusted to him always deserved special praise.

ON the 25th inst. the Pompeii celebration, to which we referred some time ago, will take place. The director of archæological excavations in Italy, Prof. Michele Ruggiero, will deliver a historical address to the assembled guests in the basilica of the ruined city. Hereupon he will lead them through the entire area hitherto laid bare, and afterwards some excavations will be made in presence of the guests.

THE Clothworkers' Company have voted 3,500*l*., beyond the 10,000*l*. previously voted, to cover the complete cost of that portion of the buildings of the Yorkshire College of Science, Leeds, which will be required for the teaching of the sciences applied to the textile industries and dyeing. They have further agreed to maintain the buildings and the operations in full effect for a period of five years from January 1 next, at a cost of 1,200*l*. per annum.

PROF. A. H. CHURCH commences a course of ten lectures on the Chemistry of Food next Monday, the 15th inst., at five o'clock, at the National Training School for Cookery, Exhibition Road, South Kensington. Mr. Church has been appointed Professor of Chemistry at the Bedford College (for ladies), York Place, Portman Square.

THE sixth Congress of Russian Naturalists promises to be very interesting, not only as to the scientific communications expected, but also as to its practical results. It is proposed to form a permanent Commission of representatives of all Russian scientific societies for the exploration of little-known parts of Russia as to their natural history and geology, with the special aim of the applications of science to agriculture and mining industry. Another Commission will be nominated for the diffusion of science among the masses of the people by means of a series of systematical lectures. A group of Russian explorers of the North proposes to form at the Congress of Naturalists a special section for all questions connected with the exploration of the North of Russia and Siberia.

THE *Courier de Tlemcen* (near Algiers) describes an interesting if somewhat fabulous discovery. It states that some miners occupied in blasting rocks in the vicinity of the picturesque cascades, discovered the entrance to a cave, the floor of which was covered with water. They ventured upon the subterranean river on a raft, and followed it for some 60 metres' distance, when it disappeared in a vast lake. Here the vault of the cave was very high and covered with stalactites. In many parts the miners had to steer their raft between colossal stalactites which reached down to the surface of the water; eventually they reached the end of the lake, where they noticed a canal extending towards the south, and into which the waters of the lake flowed. The workmen estimate the length of the lake to be 3 kilometres, and the breadth about 2 kilometres. They brought out a quantity of fish, which, they say, surrounded the raft, and which were found to be blind.

THE optical structure of ice forms the subject of a recent paper by Herr Klocke, in the *Neues Jahrbuch für Mineralogie* (1879, p. 272). He confirms M. Bertin's observation, that in formation of ice the optic axis of the crystal is placed at right angles to the surface whence the cooling proceeds; and this was the case with water at rest in a freezing mixture. Only the ice-flowers which first cover the sides of the vessel have their principal axis parallel to these. M. Bertin affirmed that the first thin ice-layer forming on water which freezes in an open vessel in cold air has a confused crystallisation, and only after thickening takes a determinate orientation. Herr Klocke differs from him here. He shows that the first needles shooting over the surface are formed parallel to the principal axis, and that then ice-plates are added to their sides, whose optic axis is at right angles to the surface of the water. In the enlargement of these lateral plates to the table of ice extending over the whole water surface, this orientation is preserved from the commencement. Tables of ice quickly formed under disturbing influences or in great cold, as also various plates of sea-ice, showed, on the other hand, aggregate polarisation. Various other observations are described.

WE hear that the preliminary operations for opening the coal-mines in the Kaiping department of the Chinese province of Chihli, to which we have before referred, are proceeding satisfactorily. From borings made last winter it would appear that six seams of good coal can be reached, and the construction of two shafts has been commenced. Good clay has been found close at hand, from which bricks will be made for lining the lower parts of the shafts, the upper portions being faced with stone already prepared for the purpose. Machinery and some miners were shortly expected to arrive from Europe, and the work would then be rapidly pressed forward.

THE temperature of the polar extremities of carbons giving the electric light has been recently investigated by M. Rossetti (*Journ. de Phys.*, August), using the same method and instruments as he used in measuring the temperature of the sun. (The face of a thermo-electric pile is placed at suitable distance to receive rays from a radiating surface of determinate size, and the thermal effect is measured by a very sensitive Wiedemann reflecting galvanometer; the temperature is deduced by means of a formula previously established.) We give, briefly, the author's conclusions:—(1) The positive carbon pole, at the moment of production of the light, has always a higher temperature than the negative. (2) These temperatures vary according to variation of the current's intensity. (3) They are higher the smaller the radiating surface, provided, of course, it comprises the extremity of the point. (4) For the negative pole the minimum temperature was 1,910° C., the radiating surface being large and, in part, of small brilliancy; the maximum 2,532° C., the radiating surface being half the preceding. (5) For the positive pole, the minimum temperature was 2,312°, the carbon being very large and the radiating surface very extensive; the maximum 3,200° when the carbon was thin and the radiating surface nearly a quarter of that corresponding to the minimum temperature. (6) We may consider the temperature of the extreme negative polar point as equal to 2,500° at least; that of the positive polar extremity is not less than 3,200°.

ON Saturday last a system of telephonic communication highly promising for the convenience of business men and others was successfully inaugurated in London. The telephone used is that of Edison (the loud speaking telephone), with the nature of which our readers are acquainted. A central station called the Telephone Exchange, in Lombard Street, is put in connection at present with ten private offices furnished with telephones in various parts of the city. The switch-board at the central office might be connected with twenty-four different stations, this being the most that can be attended to by one person. Any number of switch-boards, however, might be added in the same room, and any station on one board connected with any one on another board. An attendant, who may be a boy, sits in front of the board. Supposing No. 2 wishes to speak with No. 6, the person at No. 2 calls the attention of the central attendant by means of an electric bell, while a falling shutter on the switch-board shows the number of the applicant. The attendant responds, and No. 2 then says, "Connect me with No. 6." The shifting of a pin effects this, and Nos. 2 and 6 are left to communicate with each other. When the conversation is closed, No. 2 signals by the bell that he has finished, and the attendant, removing the pin, separates the two stations. And so with any other numbers. Of course only one station can be connected with another at the same time, but the process of coupling and uncoupling is effected very quickly. Edison's instrument, though known as the loud-speaking telephone, is also suited for conversation almost in whispers, and this was tested on Saturday with very satisfactory results. The telephone is said to have been worked in America without difficulty between stations 100 miles apart. It is considered that up to about five miles distance there is no loss of power; and in practice of the above system even five miles would probably be found an exceptional distance. The utility of the system seems fully demonstrated, and we may look for an extensive application of it in our large towns.

THE common form of speaking telephone relies for its action on currents of electricity developed in helices by the varying strength of magnetic induction when an armature moves in the magnetic field. A second genus of telephone is that which Edison has developed out of his motograph, and which depends solely on the varying friction between two surfaces, one of which is an electrolyte, when a varying current is passed between them.

Prof. Dolbear has recently (*Journ. of Frankl. Inst.*) described a third genus of telephone quite unlike the other two. A short, straight bar electro-magnet is furnished with a crank, so that it may be rotated within its coil. Lying on the poles are the ends of a bent armature (of horse-shoe form), the back of which is fastened to a plate of mica, or paper, or thin iron, mounted as in ordinary receivers, so that any motion of the armature poles will be imparted to the plate. When a current traverses the bobbin, the straight bar becomes a magnet, with strength proportionate to the strength of the current, and the armature adheres to the poles of it with a certain strength of adhesion. Now let the crank be turned slowly, and the adhesion of the armature will result in stretching the plate, and the cessation of the current will let the plate regain its former position through its elasticity. A varying current will result in varying adhesions and consequent vibrations of the plate, and talking may be plainly heard with an instrument constructed thus. Prof. Dolbear calls it the *Rataphone*. Of course there are various ways in which the principle may be utilised.

In the last number of the *Astronomische Nachrichten* Dr. Hermann J. Klein, of Cologne, publishes some further remarks regarding the new formations near the lunar crater Hyginus, which were first noticed by him, and about which there has been so much discussion in astronomical circles of late. Dr. Klein, after giving some valuable selenographical details (for which we must refer our readers to the serial mentioned), observes that for the present it must remain undecided whether the new formations near Hyginus are due to volcanic action. As far as his knowledge extends, only one observation of lunar changes may be ascribed to phenomena of a volcanic nature. This observation was made by Schröter and Olbers on July 2, 1797, and referred to a mountain, V, in the Mare Vaporum. The mountain was found to be 3,450 feet in height, and has never again been seen; it was probably only a mass of vapour. Almost at the very spot where this mysterious object was observed a crater is now visible. Dr. Klein is of opinion that at the surface of the moon masses of vapour are formed now and then and are of considerable duration, and he lays particular stress on the fact that for certain processes taking place upon our satellite all analogy with terrestrial phenomena is completely wanting. As an instance he points to the occasional occurrences at the double crater Messier. Those who are acquainted with the entire materials collected by observations of this formation, from Gruithuisen down to Schmidt, and who have themselves for some time observed the crater and its appendages, will own that here they stand before an unsolved enigma, and that, for the present, at least, it is the wisest course to abstain from any attempt at explaining the wonderful phenomena which are taking place in those regions.

The Austrian geologists are very busy at present with the excavations which are being made in the Moravian caves of Stamberg and Brünn. A few miles from the latter town the celebrated Vypustek cave is situated. This is now being investigated by order of the Imperial Academy of Sciences of Vienna, and has been repeatedly visited by Prof. von Hochstetter. The Imperial Museum at Vienna has quite recently received a collection of bones of the cave-bear, of the cave-hyæna, and of other prehistoric inhabitants of the Vypustek cave.

In a recent number we referred to the tides observed in the subterranean waters of a coal mine at Dux, Bohemia. A similar phenomenon is reported from America, where it was observed in an artesian well some months ago. A Vienna geologist therefore recommends that observations should be made at the artesian wells in Europe, to ascertain whether similar phenomena would show themselves.

In an article in the August number of the *Entomologist's Monthly Magazine*, on the recent abundance of *Vanessa cardui* over a great part of Europe, Mr. McLachlan suggests that possibly "the insect may be able to rest quiescent in the perfect state over a series of years, until the accumulated numbers simultaneously wake up."

The Russian Commercial and Technical Societies propose to send to the Berlin International Fishing Exhibition several collections of living fishes and detailed descriptions of the fishing in Russia.

In the last (August) number of the *Annali di Chimica applicata alla Medicina* of Dr. G. Polli of Milan, an interesting note by Dr. Finardi Sante of Salara (Rovigo), reports the discovery of a new method of conserving chloride of lime unchanged, *i.e.*, free from carbonate or moisture. It consists in placing into the jars containing this substance a small vessel containing a mixture of salicylic acid and salicylate of potash, then closing the jars with a non-porous stopper and preserving them in the dark.

We have received the *Anuario del Observatorio de Madrid* for 1876 and 1877; it contains much useful astronomical and statistical information. We have also received the meteorological publications of the same observatory for 1875–8; these we hope to notice at length.

During a thunderstorm at St. Cergues, in the Jura, the rare phenomenon known as St. Elmo's fire was observed. A pine forest in that neighbourhood is reported to have appeared as if on fire, presenting a magnificent aspect.

A step in the right direction has been taken by the citizens of Colorado in the formation of a Historical and Natural History Society at Denver. The leading citizens of the State have become members of the new society, the main object of which is the preservation of records, documents, relics, &c., referring to the State of Colorado. The accumulation of works on natural history and of specimens illustrating the natural wealth of the State is another object the Society has in view.

In a note to the Berlin Physiological Society, Herr Fritsch, after remarking on the difficulty of rendering bacteria in infected tissues visible, recommends Abbé's illuminating arrangement for the purpose. This consists of a hemispherical lens-system, the plane surface of which is placed close under the object. To the middle point of the system is directed a considerable quantity of daylight by means of a plane mirror, and the intensity is so regulated that, with different combinations, differently incident cones of rays are obtained.

The additions to the Zoological Society's Gardens during the past week include a Tiger (*Felis tigris*), two Indian Leopards (*Felis pardus*), from India, presented by His Excellency the Right Hon. Lord Lytton, G.C.B., G.M.S.I.; a Macaque Monkey (*Macacus cynomolgus*), a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mr. B. Raver; two great Bustards (*Otis tarda*) from Andalusia, presented by Mr. Forster; two All Green Parrakeets (*Brotogerys tiriacula*) from Brazil, presented by Dr. A. Stradling; two Common Chameleons (*Chamæleon vulgaris*) from Cyprus, presented by Mr. Alfred Ely; a European Bearded Vulture (*Gypaëtus barbatus*) from Spain, deposited; a Sœmmerring's Gazelle (*Gazella Sœmmerringii*) from Abyssinia, a Rock Cavy (*Ceredon rupestris*), a Crab-eating Opossum (*Didelphys cancrivorus*), an Ashy-headed Goose (*Bernicla poliocephala*), an Upland Goose (*Bernicla magellanica*) from South America, a Superb Tanager (*Calliste fastuosa*), a Black-shouldered Tanager (*Calliste melanonota*), a Palm Tanager (*Tanagra palmarum*), a Thick-billed Violet Tanager (*Euphonia crassirostris*), a Brazilian Blue Grosbeak (*Guiraca cærulea*), two Tuberculated Iguanas (*Iguana tuberculata*), two Horrid Rattlesnakes (*Crotalus horridus*) from Brazil, two Elegant Parrakeets (*Euphema elegans*), from South Australia, two King Crabs (*Limulus polyphemus*) from North America, purchased.

PROF. DODEL-PORT ON THE FERTILISATION OF RED SEAWEEDS BY INFUSORIA

IN a recent number of the excellent periodical *Kosmos*, Dr. Dodel-Port, the eminent Zurich botanist, has published the results of a series of observations made by him regarding the part played by some infusoria in the fertilisation of a certain species of red seaweeds or Florideæ, viz., *Polysiphonia subulata*, T. Ag. The paper is of biological importance, since it forms, as far as our knowledge extends, the first record of a possible participation of animals in the fertilisation of cryptogams, which in itself seems an interesting parallel to the relations existing between insects and phanerogams. We have pleasure, therefore, in presenting our readers with an abstract, the illustrations for which have been placed at our disposal through the kindness of the author and of the publishers of *Kosmos*.

In previous numbers of the same periodical Dr. Hermann Müller had sketched the history of the evolution of the floral world and had shown upon what basis rests the entire relation between flowers and insects. This basis is the passage from a state of things in which the male cells discharged their products in a medium of water to that in which this event took place in the dry atmosphere, which transition period occurred at the upper boundary of the cryptogamic flora of prehistoric times.

In almost all cryptogams, which are not agamic, the contents of the male sexual cells are actively movable; when they leave the male cell they move freely about in the water by means of vividly oscillating cilia. They therefore possess the faculty of moving to the distant female organ, and there to complete fertilisation. In the case of phanerogams, the independent mobility of the pollen-bodies has become an impossibility. To effect the union of pollen-grains with that particular part of the female flower which is destined to receive them, in most plants some external agent must interfere. In many cases, specially in the lower regions of the floral world, the wind, gravitation, or both together, are the agents in question; in the majority of the higher phanerogams, insects, or occasionally other animals, undertake the conveyance of the pollen.

Now there are a great number of cryptogams, in which the contents of the male cells which are emptied into the water do not possess the faculty of independent motion, as they are not endowed with cilia, and are therefore dependent on the action of external forces for their locomotion. To these belongs the great and highly differentiated order of so-called red seaweeds or Florideæ, chiefly marine plants which vary much in form and colour, and which no one who has ever attentively observed on the sea-coast will ever forget. Their antherozoids, which are generally spherical, are discharged into the water as motionless cells, and are yielded up to the play of currents in the same way as in our anemophilous phanerogams, the pollen grains pass as a dust into the air, and are moved to and fro by the winds. There are many analogies between Florideæ and higher phanerogams, regarding their sexual conditions. Thus, amongst the former we find many species which are diœcious, similar to the lowest phanerogams amongst gymnosperms, and to others of higher order. The chances for fertilisation in their case are therefore quite similar to those applying to diœcious phanerogams. Often the male plants grow at a considerable distance from the female plants of the same species. In the spring of 1878 Dr. Dodel-Port, during a series of microscopical examinations of the red seaweeds of the Adriatic, extending over four weeks, found only female and agamic (tetrasporous) specimens of *Polysiphonia subulata*, T. Ag., and looked in vain for male specimens, of which only at the end of his investigations he could obtain a few. Their respective localities of growth were evidently considerably apart, and yet at all times Dr. Dodel-Port found female specimens in all stages of fertilisation. The spermatozoids discharged by the male plants therefore found their way to the distant female plants in spite of their own immobility and general passive behaviour. The sea-water must therefore have frequently been in vivid motion.

These facts being ascertained, the thought easily suggested itself that possibly animals might take part in the fertilisation, particularly as there is never a want of small marine animals roaming about in the Florideæ forests, such as infusoria, crustacea, annelids, starfish, &c. But what particularly attracted Dr. Dodel-Port's attention was the regular occurrence of innumerable bell-shaped animalcules (*Vorticella*) on the shrub-like branches of *Polysiphonia subulata*. In the course of closer investigation of the phenomena of fertilisation in the female organ, during and after the adherence of the antherozoid with the trichogyne, Dr. Dodel-Port eventually arrived at the full conviction that in the case of Polysiphonia the little Vorticellæ facilitate the conveyance of the antherozoids to the trichogyne, and that they act according to a natural law in the same way as do the pollen-collecting bees when by visiting the willow-catkins they assist at their fertilisation. The investigation of the sexual conditions of Florideæ is as yet in its infancy; it is to be hoped that more numerous researches in this direction will shortly be made, and possibly relations may be found to exist between other species of this order and certain animals similar to those discovered by Dr. Dodel-Port in the case of Polysiphonia and Vorticella. The details of the interesting relations in this case are shortly as follows:—

Fig. 1 represents the male reproductive organ (antheridium) of *Polysiphonia subulata* magnified 480 times. These antheridia often appear in large numbers at the upper branch-ends of the male plant, laterally close to the apex which continues its growth, at the spot where, in the vegetative state, young branches would form. In their earliest stage the antheridia consist, like the young branches, of a single row of cells. By repeated longitudinal and lateral divisions a polycellular body is soon formed, which begins with a short stem-cell (*st*), and which, on the side furthest away from the maternal thallus-branch, is protected by a forked hair (*gh*).

The ripe antheridium in external appearance reminds one very strongly of a maize cone; a row of 4–6 cylindrical cells (*a*, *a*) in the axis of the whole organ represent the spine of the cone, while the surface is covered over by numerous antherozoid mother-cells (*sm*, *sm*) representing the grains of maize. Before the antheridium is ripe the latter are polyhedrical, but afterwards they assume a round shape, as the drawing shows. All parts of the male organ are colourless; the antherozoid mother-cells are filled by a finely granular plasma, which is soon differentiated into a round body, which subsequently is discharged from the mother-cell as an antherozoid (*s*, *s*). Thus within a short time the ripe antheridium discharges some 400–800 ball-shaped antherozoids into the surrounding sea-water. The single antherozoid is a little globule of protoplasm, without cell-wall or any locomotive organ. In the centre of this globular primordial cell a strong magnifying power shows a little nodule which strongly refracts light, and round which a few smaller colourless plasma granules are grouped. As it freely floats in the water, the antherozoid is analogous to a pollen-grain of an anemophilous phanerogam.

The female reproductive organ of *Polysiphonia subulata* is a polycellular carpogonium of relatively high differentiation. It originates upon the female plant closely below the apex of the thallus-branches, and generally there are several of them forming successively at varying intervals from the branch-end downwards.

Fig. 2 shows the carpogonium-bearing branch-end of a female specimen of *Polysiphonia subulata*. *cg'* is a very young carpogonium; *cg*, *cg* are two mature ones; *t'* and *t''* are two trichogynes; *Vort.* are two Vorticellæ. The whole is magnified 300 times.

In Fig. 3 a carpogonium (*ca*) is represented magnified still more (480 times). *Vort.* is a Vorticella; *s*, *s* are antherozoids. In the mature state the carpogonium consists of three essential parts, viz.:—

1. The basal portion *f* (Fig. 3).
2. The fertile spore-forming part *cg*.
3. The hair apparatus *t* and *gh*.

The basal portion consists of five tubular cells running parallel to each other, of which in Fig. 3 are seen only two. Then follows the fertile part, *cg*, which is an oval cellular body, consisting of some 20–26 cells. A central cell, copiously filled with granular protoplasm, is surrounded by a number of irregular, peripheric cells, and awaits fertilisation, in order afterwards to transform itself into the spore-forming apparatus, while the remaining 19–25 peripheric cells become the case of the spore fruit through further divisions (see also Fig. 4, *h h*). The uppermost part of the female organ is the hair apparatus, which, in Polysiphonia, consists of the forked hair, *g h*, and the trichogyne, *t* (Fig. 3). The forked hair forms very early upon the young carpogonium, and indeed long before the trichogyne is formed; its position is always upon the true apex of the whole organ, although at times it stands apparently laterally from the apex. The duration of its existence and its presence at the time of fertilisation (it disappears immediately

afterwards) prove it to be an organ of some use in that process. The most essential and important part of the hair apparatus, however, is the trichogyne (*t*, in Figs. 2 and 3), *i.e.*, the receptive organ, which in Florideæ has a similar signification to that of the elongated style in many phanerogams, while the central part, *c g*, of the carpogonium is the analogue of the closed

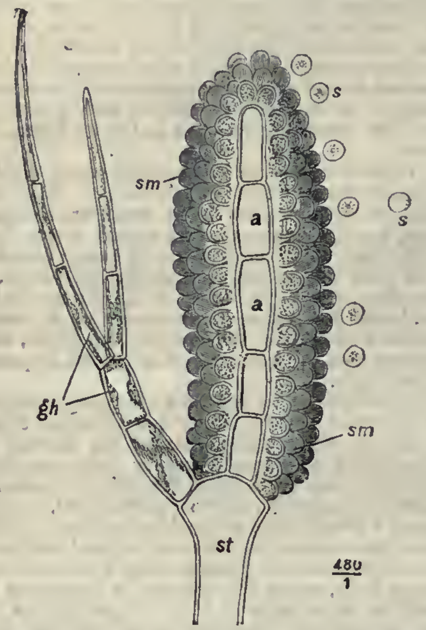


Fig. 1.

ovarium of angiosperms. The trichogyne is a slender, colourless hair, consisting of but a single cell, which rises from the carpogonium laterally from the apex of the latter, and does not quite attain the length of the forked hair, *g h*. It forms just about the time when all other parts of the carpogonium have attained that degree of differentiation which they possess during

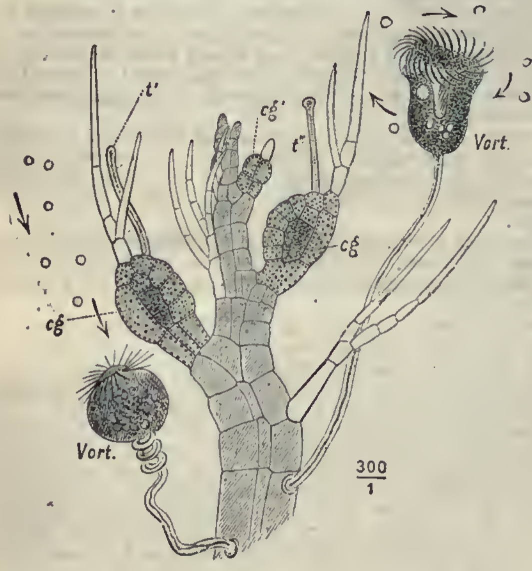


Fig. 2.

fertilisation. In the full-grown state the trichogyne is of the same thickness in its entire length, and rounded off suddenly at the upper end. The narrow canal of the trichogyne contains colourless, finely-granular protoplasm.

Now if antherozoids of *Polysiphonia subulata*, which were freshly discharged by the antheridia and have been accidentally carried near by currents, come into contact with the upper part of the trichogyne, they get firmly attached to the latter. It is particularly the apex of the trichogyne which possesses the faculty of retaining the globular antherozoids. Then the granular protoplasmic contents of the antherozoids pass into the

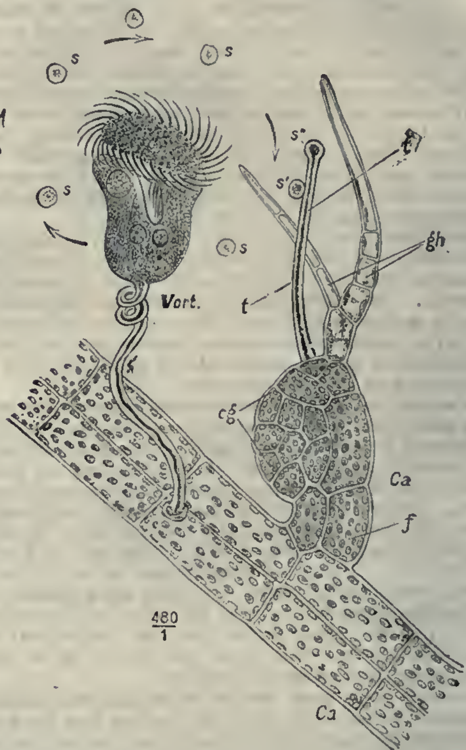


Fig. 3.

interior of the trichogyne (Fig. 3 *s''*). A part of it descends down the trichogynic canal into the carpogonium, giving the fertilising impulse to the central cell of the carpogonium. This process is quite similar to the corresponding one in phanerogams.

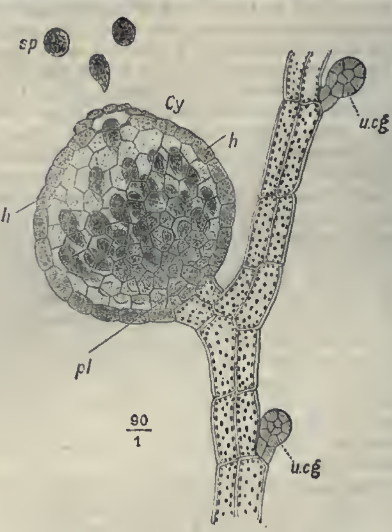


Fig. 4.

As the antherozoids of Florideæ are totally devoid of active locomotive organs, the possibility of fertilisation, *i.e.*, the coming into contact of the antherozoids and the trichogyne, of course rests entirely upon a lucky chance. The antherozoids reach the female organs passively, either by their own weight or through

the currents of the water, caused by waves, wind, or tides, and doubtless in many cases through the incessant movements of some marine animals. The greater the distance between the antheridia and the carpogonia, the smaller are, of course, the chances of fertilisation; the more violently the water is moved about in the vicinity of and between the separated organs, the more probably will the lucky accident of the union of both elements take place.

During a long series of investigations of the reproductive phenomena of Polysiphonia, Dr. Dodel-Port found regularly on the bushy thallus, and particularly upon the uppermost and youngest branches, an enormous number of the well-known stalked animalcules, Vorticellæ, which had settled there, and were, as usual, in incessant motion. Often they appeared in dozens in the field of the microscope, and, with the constant vibration of their cilia, they were very troublesome, at least up to the moment when Dr. Dodel-Port had directly observed their friendly co-operation in the fertilisation he was studying. He was a frequent witness of the process depicted in Fig. 3, where numerous antherozoids were whirled round and round in the whirl caused by a Vorticella, and where frequently antherozoids came into contact with the trichogyne, and remained attached to it (Fig. 3, *s′* and *s″*) for a longer or shorter period. It was entirely due to the motion caused by Vorticellæ that Dr. Dodel-Port was enabled to follow the phenomenon of the attachment of the antherozoids to the trichogyne from beginning to end. The motions of the Vorticellæ are particularly varied through the repeated contractions of their stalks into short spirals, and thus they cause various currents in the water, by all of which the antherozoids are carried along like any other small passive body that may be suspended in the water. (Compare Fig. 2, where one of the Vorticellæ is just contracting its stalk, the arrows in each case indicating the direction of the currents.)

The presence of numerous Vorticellæ thus imparts to the passive antherozoids a kind of motion much resembling that of the sperm-cells of other cryptogams which are endowed with active cilia. From this follows, with mathematical certainty, that the probability of the antherozoid falling on the trichogyne in the presence of Vorticellæ is immensely greater than that which would exist were there no animals present.

At the same time, it is evident that this probability is yet increased in the case of *Polysiphonia subulata* through the presence of the forked hair, *g h*, in the vicinity of the trichogyne, because the whirls caused by the animalcules will often be cleft by the forked hair, and thus secondary whirls will be produced. Often in Polysiphonia, carpogonia were found which were not fertilised. Thus Fig. 4 represents a ripe and spore-ejecting cystocarp, *c y*, and two carpogonia, *u c g*, which remained unfertilised. This was particularly the case on thallus-branches, which were less densely crowded with Vorticellæ—another, although negative, proof of Dr. Dodel-Port's theory. It is not particularly remarkable that Vorticella should inhabit Polysiphonia in large numbers, because these animalcules, as Dr. Dodel-Port observed, feed with predilection on the antherozoids of this plant. Thus we have here a condition of things similar to the relations between certain flowers and pollen-consuming insects. The consumption of antherozoids by the Vorticellæ is, of course, far too insignificant to merit any consideration, particularly if compared to the great advantages regarding fertilisation which the presence of the animalcules brings with it. Moreover, a comparison of the male plant of Polysiphonia with a female specimen shows that here also, as in most phanerogams, thousands more male cells are formed than are necessary for fertilisation.

After fertilisation the carpogonium develops into a cystocarp, *i.e.*, the spore-forming fruit (Fig. 4). Shortly after fertilisation the whole hair apparatus disappears. The wall-cells of the carpogonium now begin to grow quickly and to divide by membranes perpendicular to the surface. They form a cellular case (*h h*, Fig. 4), which has an orifice in the apex, long before the spores are ripe. In the meantime the central cell of the fertilised carpogonium begins to form a number of densely-packed short branches, which, as a series of cells radiating in all directions, fill the basis of the capsule-shaped fruit. The central cell is therefore called the placenta-cell. At the ends of the ramified cell-series which radiate from it, pear-shaped and dark red spores form (carpospores), which, as soon as they have attained a certain size, become detached and pass into the water through the orifice at the apex of the cystocarp. In this state they are perfectly capable of further development and soon begin to germinate.

Dr. Dodel-Port concludes his interesting treatise with the following suggestive sentences:—

"The total absence of active organs of locomotion in the antherozoids of Florideæ points to a common ancestor from which the different branches of the Florideæ have inherited the immobility of the antherozoids. No doubt that during the differentiation of the red seaweeds many forms have died out in consequence of the fertilisation not taking place through the passivity of the male cells, while other forms have retired to localities which through active water-currents favour the process of fertilisation in spite of the immobility of the antherozoids. It is well known that now we find most of the present species of Florideæ on the coasts of warmer seas, which are constantly washed by the waves, while the northern coasts, which are covered by crusts of ice during a great portion of the year, are very poor in red seaweeds. Future researches will have to show how far in many of these aquatic plants the differentiation of the genera took place in the sense of an adaptation to the small marine animals which inhabit them and favour their fertilisation in the way I have pointed out. If many seaweeds in their bushy shrub-like thallus harbour certain infusoria, bryozoa, hydræ, sponges, crustacea, annelids, and small starfishes, and offer to them excellent hiding-places or nourishment, so that these animals inhabit them with special predilection, then it is certainly possible that occasionally a correlation was formed or adaptation took place, which was mutually advantageous and which would find numerous analogies in the domain of the multiple cross relations between the higher flowering plants and insects. In this sense I consider it my duty to submit to the criticism of biologists a point hitherto overlooked in the biology of red seaweeds, and bearing upon the explanation of the morphological differentiation of submerged aquatic plants."

THE BRITISH ASSOCIATION

REPORTS

Report of the Committee appointed for the Purpose of Arranging for the Occupation of a Table at the Zoological Station at Naples, the Committee consisting of Dr. M. Foster, Prof. Rolleston, Mr. Dew-Smith (Secretary), Prof. Huxley, Dr. Carpenter, Dr. Gwyn Jeffreys, Mr. Sclater, Mr. F. M. Balfour, Sir C. Wyville Thomson, and Prof. Ray Lankester.—Since we submitted our last Report to the Association, the Zoological Station at Naples has continued to be successful in providing opportunity and appliances for naturalists studying the various forms of marine animals and plants. From September 1, 1878, to the end of July, 1879, twenty-six naturalists have occupied the tables at the Institution. A list of their names and the time of stay will be found appended. During the same period, packages of specimens have been forwarded to fifty-one different naturalists and institutions. A list of these is also appended.

Recently a new department has been added to the station. Through this naturalists will be enabled to obtain mounted specimens of microscopic animals, viz., sections of embryos of all kinds of fishes, &c., preparations of larvæ or other animals too small for being sent in alcohol or other preservative solutions. Next year a catalogue of these specimens will be published, and the station will be prepared to send the specimens to any naturalist requiring them.

Trials of diving by means of the new Scaphander apparatus have also recently been made with very satisfactory results.

The aquarium of the station is being in part reconstructed, with some important new features, viz., moveable rockwork, for saving and examining the different animals which thrive by themselves on these rocks. This will enable statistical notes to be established on the growth of these animals, and on such changes as may occur by changing their habitat, inasmuch as these rocks may be replaced in the sea at different depths.

The following monographs are in preparation by workers in the station:—Ctenophoræ, Fierafer, Balanoglossus, Sipunculoidæ, Capitellidæ, Planariæ, Nemertineæ, Pycnogonidæ, Caprillidæ, and on several families of Algæ.

Three parts of the "Mittheilungen aus der zoologischen Station zu Neapel, zugleich ein Repertorium für Mittelmeerkunde" have been published, containing sixteen papers illustrated with many very carefully executed plates. Further parts are in active preparation.

It is, moreover, intended to publish the following works:—

"Fauna und Flora des Golfes von Neapel und der angren-

zenden Meeresgebiete." Folio. Yearly, 1 volume with 10–20 plates. The first volume is already in the press.

"Prodromus Faunæ Mediterraneæ." A selection from the whole zoological literature of short Latin diagnoses of the animals found in the Mediterranean, with their habitats and local names.

"Zoologischer Jahresbericht." This will contain short notices on the various memoirs and papers published in various countries on the subjects of zoology, development, and comparative anatomy. It is under the editorship of Prof. Carus, with the assistance of four collaborateurs in different countries. One volume will appear yearly.

Two naturalists have occupied the table hired by the Association, viz., Mr. Walter Percy Sladen and Mr. Patrick Geddes. Mr. Sladen has sent in a report on his stay and his work, which is appended. In this report he proposes "a means by which the table might be even more frequently occupied than it has been, and its sphere of utility thus extended, by suggesting to the consideration of the Committee that a further additional grant might be made by the Association, which would serve as a travelling fund. This might be apportioned in moieties say of 25*l.* to naturalists who desired to avail themselves of such assistance, and it is not improbable that many a student would by this means be enabled to participate in the advantages of the table at Naples, who might otherwise be deterred by the expense of the journey. The plan, extended or modified according to circumstances, is one adopted by several of the foreign bodies having tables at the Zoological Station."

Mr. Patrick Geddes worked at the station from February 26 to April 4. He "repeated and extended certain observations on echinoderm histology, and made experiments on *Bonellia viridis* and *Idotea viridis*, with a view of ascertaining the function of their (supposed) chlorophyll." The results of these studies are at present being published in the *Archives de Zoologie expérimentale* of M. de Lacaze Duthiers, viz., "Etudes sur le Chlorophylle animale," "Observations sur le Fluide periviscérale des Oursins."

Mr. Geddes also gained information on the working of the station, in the hope (now realised) of helping to found a zoological station in Scotland. This station is now in working order at Stonehaven.

Mr. Arthur Wm. Waters, who worked at the Association table last year, intends again to apply for the appointment to occupy it, with a view of extending his researches on the bryozoa of the Bay of Naples, already published in the *Annals and Magazine of Natural History*, 1879.

Your Committee think that the above particulars are sufficiently encouraging to induce the Association to renew the grant of 75*l.* for the ensuing year.

Report on the Occupation of the Table, by Mr. W. Percy Sladen.—In conformity with the requirements of the Committee of the British Association appointed in connection with the Zoological Station at Naples, I beg to submit the following report concerning my occupancy of the table which I had the privilege of using.

In availing myself of the opportunity of working at Naples, the main object which I had in view was that of studying the premature stages of the echinodermata, and more especially the growth-phases which intervene between the period when the pluteus is resorbed and that at which the adult characters are developed—the range and significance of these changes being very important and remarkable throughout the group. In addition to this chief object, it is scarcely necessary to add that there were numerous points in the morphology of echinoderms upon which, as a specialist, I was anxious to direct my attention, should time and opportunity permit.

I arrived in Naples on December 3, 1878, and remained there until February 17, 1879. During the greater portion of the time the weather was very inclement and stormy; in consequence of which the pelagic larval forms that I had hoped to have met with, by use of the surface-net, were driven to too great a depth, and owing to their microscopic proportions became thus altogether inaccessible. For this reason I was greatly disappointed in my expectations, and the material which I was able to obtain, in any way available for my projected investigations, was unfortunately very scanty; nevertheless several premature forms of considerable interest were procured, and these I am hoping still further to elucidate, before the end of the year, by finding, if possible, the corresponding and intermediate stages on our own coasts, and which will then enable me to work out the development of at least one or two forms completely. I also endeavoured to contribute somewhat to this subject by means of the artificial fertilisation of ova in several different families, but was always unsuccessful in keeping the *plutei* alive beyond a certain stage; whilst the fact that those thus raised in confinement were subject to very considerable abnormality in their development and present unnatural modifications which require much care and skill in elimination, in order to avoid error in subsequent deductions, greatly diminishes the utility of such observations as a direct method of embryological study, although they are not without value as furnishing some indication of the plasticity inherent in a given form.

Better success rewarded what I may speak of as desultory investigations upon the general structure of echinoderms. I may mention that I have in hand a contribution to the knowledge of *Pedicellariæ*, which I consider will throw light (if not entirely, at least in part) upon the functions of these obscure appendages. It was also my good fortune to discover in certain asteroids an hitherto undescribed organ, most probably performing sensorial functions; an account of which I hope to publish shortly, as soon as time permits me to work up the material which I collected more exhaustively than I was able to do whilst staying at Naples. In addition to the above I am also hopeful of furnishing a communication upon the premature anatomy of certain young echinoderms, for which purpose I was able to preserve and bring back with me several very good series of specimens.

The general success and continually increasing prosperity of the Zoological Station at Naples are now so fully known from the reports and various publications emanating from the institution itself, that it would be presumption on my part to offer any remarks in such a direction. I consider, however, that it is a duty for me to bear my individual testimony to the admirable arrangements which characterise the working of the station, and which conduce so greatly to the comfort of naturalists engaged in studying there. The daily supply of fresh material, the tank and aquarium accommodation for keeping the same alive, are highly satisfactory, and leave little to be desired; whilst in the way of ordinary laboratory apparatus and reagents no reasonable requirement is unprovided for.

I also desire to record my indebtedness for the genial kindness and the ever-ready assistance which I met with not only from Dr. Dohrn and the acting director Dr. Eisig, but the same friendly spirit of courtesy and help was accorded me without exception by every gentleman connected with the staff.

The utility of the Zoological Station being now so thoroughly established, and its reputation world-wide, it is unnecessary for me to allude to the fact, except to point out that the maintenance of such an undertaking is very costly, and that of necessity the results can only be continued by keeping up the funds. So much good work has already emanated from the station at Naples that the institution has a fair claim not only upon biological specialists, but on every one interested in the advancement of science. Upon such an argument, therefore, the Zoological Station is particularly worthy of the support of the British Association, even if its members were not (as many of them have already been) individual participants in the advantages which the station provides; and on this ground I would strongly urge the continuance of the grant usually made by the Association.

I would further beg to propose a means by which the table might be even more frequently occupied than it has been, and its sphere of utility be thus extended.

In conclusion I desire to express my cordial thanks to the Committee of the British Association for the privilege of using the table at their disposal. W. PERCY SLADEN

Exley House, near Halifax, August 2

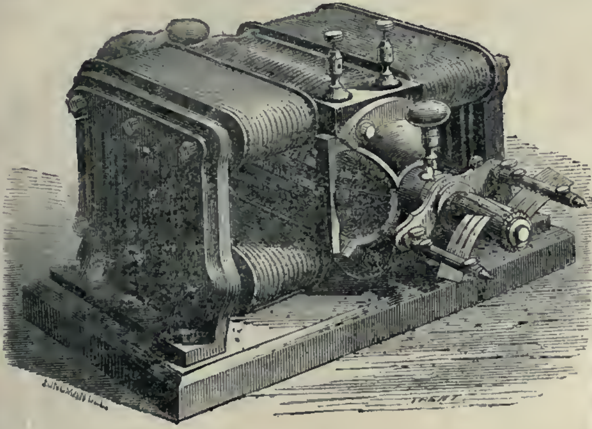
[A list of the naturalists who have worked at the Station, and of those to whom specimens have been sent during the past year, will be printed in the *Annual Report*.]

SECTION A—MATHEMATICAL AND PHYSICAL

On the Cause of the Bright Lines of Comets, by G. Johnstone Stoney.—Dr. Huggins and other observers had seen the bright lines of the carbon spectrum in the spectra of several comets. This established the fact that some compound of carbon was present in comets. In what had been hitherto written on this subject it had always been assumed that the compound of carbon was incandescent, and on that account emitted these bright lines. Mr. Stoney suggested, however, an alternative hypothesis which he believed to be entitled to much weight, viz., that these lines

were due to the sun's light falling upon the compound of carbon and rendering it visible, in the same way that light renders the moon, the planets, and other opaque objects visible, the vapour of carbon being opaque in reference to the particular rays, which appear as bright lines in its spectrum.

On Improvements in Dynamo-Electric Machines, by W. Ladd.—My object in this communication is to describe in a few words



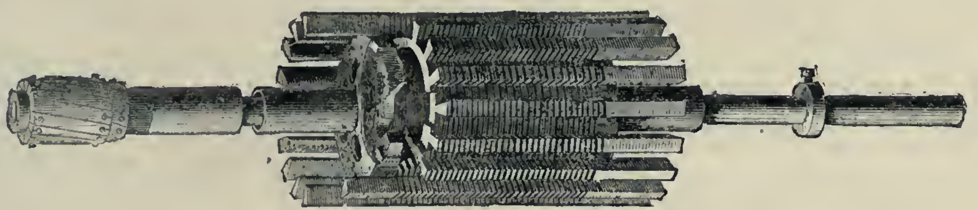
Weston's Dynamo-Electric Machine.

the peculiarities and improvements in the construction of Weston's dynamo-electric machine.

The Field Magnets.—The general appearance and arrangement of which may be seen in the illustration. The pole pieces are composed of iron plates, placed side by side in a mould, but separated a uniform distance from each other. The iron magnets, on which the wire is to be wound, are cast on to "lugs," or projections on the ends of the plates. The two cast-iron ends and uniting plates form one magnet; the upper and lower magnets are alike, and when joined together by the perforated vertical supports, the inner curved edges of the field plates embrace about two-thirds of the circle in which the armature is made to revolve.

The armature is built up of plates which are somewhat like a cogged wheel in shape (see illustration). These plates are stamped out of sheet-iron, and when mounted on the shaft are separated from each other at a uniform distance; the radial projections are then arranged in lines, so that the whole forms a very broad cogged wheel, or cylindrical structure having longitudinal grooves, with transverse spaces at regular distances. The longitudinal grooves are for carrying the wire, and it will be observed from the nature of the structure that the wire lies in channels three sides of which are iron; so that the mutual effect upon each other is increased as much as possible. The ends of the wires are connected to the field magnets and commutator in much the usual way, the currents travelling in one direction only. The commutator is fitted on a portion of the shaft which projects beyond the bearings. This admits of its easy removal and a new one being replaced in three minutes.

Another important feature in the construction is the arrangement for ventilation; the separation between the pole plates of the field magnets, the perforation in the vertical supports of the magnets, and the light frame-work of the armature, are all for this purpose. The air enters the centre of the armature, and is



Armature of Weston's Dynamo Electric Machine

driven out between the layers of wire through the spaces formed by the separated plates of the armature and the field magnets, and thus prevents any part from becoming unduly heated.

Machines of this description are made of various sizes and strengths, and give from one to sixteen lights in single circuit.

On the Direct Motion of Periodic Comets of Short Period, by Prof. H. A. Newton.—The periodic comets of short period, that is, the comets certainly seen at two returns, twelve or fifteen in number, have, all but one or two, small inclinations to the ecliptic; Halley's comet is an exception, being nearly retrograde in motion. Perhaps we may add the comet with which the November or Leonid meteors are connected (1866, 1), since it is, I think, almost certainly identical with the comet of 1836, and has an inclination of about 163°.

The direct motion of the periodic comets seems to give them a peculiar relation to the solar system, even suggesting for them an origin common in some way with the origin of the planets. The other comets apparently come to us from outside the solar system, and if in any cases they are permanent members of the solar system, they have become such by the perturbations of the planets. Can it be that such perturbations have also forced the periodic comets into their present orbits?

The ordinary perturbating forces are small, and would almost as frequently increase as diminish the inclination of a comet's orbit. To every comet passing on one side of a planet, and so having its inclination diminished, there should be among an indefinitely large number of comets a second comet passing on a symmetrically opposite side, and having its inclination increased. But if we state the question properly, we get a different answer. If an indefinitely great number of comets approach and pass a large planet, and if the directions and lines of motion are uniformly distributed, some of those coming near to the planet will be turned into orbits of short period. Considering only the orbits thus affected, will they have in general small inclination? I find that they will, and that therefore we are not required, because of their different motions, to consider the periodic comets of short period as different in genesis from those of long period, or from those having parabolic orbits.

The conclusion suggests the possibility of a common outside origin to the periodic comets and the asteroids. It also suggests the possibility of an outside origin for the matter that makes up the zodiacal light, since it would explain the near coincidence of the plane of this mass with the ecliptic, notwithstanding its outside origin.

If, in addition, we may admit a like origin for the satellites, and even for some of the smaller planets, we are rid of the difficulty that seems to me insuperable, of supposing, as is usually done, that the very small bodies become solid from a nebulous state in the immediate presence of the sun and large planets.

On Self-acting Intermittent Syphons and the Conditions which Determine the Commencement of their Action, by Rogers Field, B.A.—In an extensive series of experiments which the author tried some years ago on syphons, with their outer legs dipped in water, he was much puzzled by finding that the quantity of water necessary to put a syphon of given size into action varied in the most unaccountable way at different times. The only difference that could be perceived between the cases in which the syphon started and those in which it did not start was, that in the former case air-bubbles escaped freely at the mouth of the syphon, whereas in the latter case, under apparently the same conditions, very few bubbles came out. At last the idea suggested itself of making a portion of the syphon in glass, so as to see what was going on inside the pipe, when the course of the irregularity was at once discovered. Sometimes the water which ran over the bend adhered closely to the sides of the pipe, at other times a portion of it would fall more or less clear of the sides. When the water adhered to the sides it produced very little effect in displacing the air, so that only a small quantity of air was driven through the water at the mouth of the syphon. When on the other hand the water fell clear of the sides, it produced a great effect in displacing the air, and large bubbles of air at once escaped from the mouth of the syphon.

The investigation was pursued further by producing artificial irregularities in the pipe, and it then appeared that the more completely the water could be thrown clear of the sides of the pipe, the greater effect it produced in expelling the air and starting the syphon.

The author applied this and other principles in his intermittent syphon, of which a working model was exhibited, and which was illustrated by diagrams. Self-acting syphons have been used in emptying vessels for measuring water, as in Osler's and Bickley's self-recording rain-gauges; and the syphon described might be so employed and also in a more practical manner, such as for flushing sewers by water which usually runs to waste.

Mr. W. E. Ayrton read a paper by Dr. Muirhead *On the Constancy of the Capacity of Certain Accumulators*, and a note thereon by Mr. C. Hockin. The latter communication contained an account of observations which were first begun with the object of redetermining the capacity of certain condensers employed in the testing of cables, and in terms of which the capacity of many cables now submerged have been recorded and published. In consequence of these papers a committee was appointed by the Association, on the recommendation of Section A, for the purpose of deciding upon an authoritative standard of electrical capacity.

Prof. G. Forbes made some remarks upon *The Bursting of Firearms, when the Muzzle is closed with Earth, Snow, &c.*—This well-known fact was explained in a simple manner. If the charge moved slowly, of course very small pressure of air would drive out the obstacle, which offered a very small resistance; but in practice the charge travelled with a speed of more than the velocity of sound. The mathematical investigation showed that the pressure generated with a plug of the density of air is $7\frac{1}{2}$ tons. The complete investigation is to be found in the *Proceedings* of the Royal Society of Edinburgh.

The Section devoted Saturday as usual to the mathematical papers, which were not so numerous as they have been in recent years.

Mr. H. M. Jeffery gave an account of his work *On Plane Class Cubics with Three Single Foci*, which concluded his enumeration of curves of the third class; and Mr. W. H. L. Russell communicated a theorem *On Linear Differential Equations*.

Mr. J. W. L. Glaisher gave an account of *Some Enumerations of Primes of the Forms* $4n + 1$ *and* $4n + 3$, referring to the investigations of Prof. Tchebycheff, who had shown that primes of the form $4n + 3$ were more numerous than those of the form $4n + 1$, the difference in the numbers of primes of the two forms up to a certain large limit x being for certain values of x of the order $\frac{\sqrt{x}}{\log x}$. Mr. Glaisher also communicated an elementary method of summing the series

$$\tan^{-1} x^{2n} + \tan^{-1} \frac{x^{2n}}{2^{2n}} + \tan^{-1} \frac{x^{2n}}{3^{2n}} + \&c.,$$

and similar series, and also some formulæ in elliptic functions.

Mr. A. J. C. Allen read a paper *On some Problems in the Conduction of Electricity*, the principal object of which was to solve the problem of the conduction of electricity in a spherical current sheet, the electricity being introduced and carried off from the sheet at any number of points, called electrodes; and also to do the same for certain finite portions of a spherical sheet, bounded either by current or equipotential lines, the motion being in all cases steady. This was effected by means of a theorem, which was then applied to deducing solutions for a number of finite areas on the sphere. The case of one source and an equal sink on a complete sphere was discussed in detail, and the current and equipotential lines shown to be two systems of small circles. A similar theorem, though not quite so universal in its application, was shown to hold for a sheet in the shape of a circular cylinder. The paper concludes with a solution in singly infinite series of the problem of the conduction of electricity in a plane area, bounded by two concentric circles, and also in that bounded by two concentric circles and two radii, meeting at an angle $\frac{\pi}{n}$ (n integer).

SECTION B—CHEMICAL SCIENCE

Notes on Recent Spectral Observations, by J. N. Lockyer, F.R.S.—The following results have been obtained by the method recently described to the Royal Society (*Proc.* R.S., vol. xxix. p. 266 :—

1. Carefully distilled sodium condensed in a capillary tube, and placed in the retort, gives 20 volumes of hydrogen.
2. Phosphorus carefully dried gives 70 volumes of gas, chiefly hydrogen, which, however, is not PH_3, although it gives some of the lines of phosphorus. It is not PH_3, because $CuSo_4$ is not touched by it.
3. Magnesium carefully prepared by Matthey is magnificent in its colourings; we get first hydrogen, then the D line [not sodium, for the green line is absent], then the green lines of magnesium, (*b*) then blue line, then various mixtures of all of them, as the temperature is increased, D being always the brightest, 2 volumes ($\frac{1}{2}$ *cc*) of hydrogen only were collected.
4. With gallium and arsenic the pump always clicks, indicating that no gas is given off.
5. From sulphur and some of its compounds there is always So_2.
6. From indium, hydrogen comes over before heating.
7. Lithium gives 100 volumes of hydrogen.

The conditions of the experiments have always been the same, the only variable being the substance. The volumes stated are those generally obtained; almost all experiments are ended by the cracking of the tube.

On large Crystals of Mercury Sulphate, by Philip Braham.—Mr. Braham exhibited crystals which had taken over two years in forming, and were due to the presence of a trace of nitric acid in the sulphuric acid in which they were formed.

On the Manufacture of Crucible Steel, by Henry S. Bell, F.C.S., &c.—The manufacture of crucible steel is one of the most important industries connected with the town of Sheffield, which boasts of not less than 120 firms engaged in the production of this material. Notwithstanding the enormous output of steel by the Bessemer and Siemens-Martin processes, this kind of steel is unrivalled for the manufacture of the finer varieties of cutlery and edged tools, &c. A brief outline of the process itself is as follows:—The most of the iron employed for this purpose is imported into this country in the shape of bars from Sweden, where it has been smelted from very pure iron ores, in a blast furnace, by the aid of charcoal, and subsequently puddled to free it from impurities.

The first operation to which it is subjected, is that known as the cementation or converting process, the object of which is to combine a certain quantity of carbon with the iron; this operation is performed in a furnace of peculiar construction, where the iron and charcoal are packed together in air-tight chests or converting pots, subjected to a high temperature short of the fusing point of iron, where it remains for a matter of three weeks.

After the conversion, when the pots are cold the bars are taken out and found to be covered with blisters, hence it is termed blister steel. In consequence of the various theories proposed to account for this peculiar formation, the writer was induced to make a series of investigations. For this purpose he was kindly furnished by Messrs. Seebohm and Dieckstahl, of the Dannemora Steel Works, with some samples of this blister steel, various portions of which he submitted to analysis, the results of which showed a marked increase of silicon where the blisters occurred.

On inspecting one of these bars of blister steel, it is found that it has undergone both a physical and a chemical change.

The iron has now assumed a crystalline structure, and has chemically combined with a certain amount of carbon. This latter change commences on the exterior, and extends itself to the interior of the bar, if the process be continued sufficiently long, thus showing that carbonic oxide never penetrates into the centre of the bar, until the whole is converted into steel.

The writer is indebted to the kindness of the above-mentioned firm for a sample of bar iron, before and after conversion, in order to ascertain the exact chemical change that took place during the process. The following are the results obtained:—

	Before Conversion	After Conversion
Fe	99·471	98·603
C	0·352	1·250
Si	0·050	0·035
S	0·027	0·022
P	0·025	0·018
Mn	0·075	0·072
	100·000	100·000

The decrease in impurities appears greater than it really is, owing to the fact that the bar itself has increased in weight by the addition of carbon.

One remarkable fact is that, after the conversion of the iron, a quantity of the charcoal, in the converting pots, is found in a pulverised state, so as to be unfit for further use.

Some of this waste charcoal the writer has examined, and from one sample, by the aid of a magnet, he succeeded in extracting 5 to 6 per cent. of iron scale, and small pieces of steel, these on being treated with dilute hydrochloric acid, evolved considerable quantities of sulphuretted hydrogen; in one case he estimated the quantity of sulphur, and found it to contain as much as 1·25 per cent. of this element.

The steel is now broken up into small pieces and melted in crucibles, and cast into ingots. These are sent to the forge, where they are heated and rolled. In this part of the process the chief difficulty with which the silter has to contend is the porous or "honey-combed" structure of the steel.

One of the characteristic features relied on by practical men as indicating the quality of a piece of steel is the appearance of its fracture; but this is by no means an infallible test, as the fineness or coarseness of grain can be produced by mechanical treatment or chemical means.

The characteristic property possessed by steel is its capability of being hardened and tempered. The temper of cast steel may be said to range from 0·75 to 1·50 per cent. carbon. The temper of steel is an important question in connection with the purpose for which it is required; thus a steel containing 1·50 per cent. of carbon is the class employed for razors. 1·25 per cent. is that known as "tool temper." Steel containing 1·00 per cent. carbon is termed "chisel steel," and this temper is extensively used in the arts.

The latter part of the paper is occupied with the consideration of the manner in which bodies such as carbon, silicon, sulphur, phosphorus, and manganese, affect the quality and mechanical properties of the steel.

A Lecture Experiment in Illustration of the Hollway Process of Smelting Sulphide Ores, by Alfred H. Allen.—By causing oxygen gas to bubble through molten antimony sulphide contained in a V-shaped piece of combustion-tube, combustion takes place with such rise of temperature as to soften the glass, while a sublimate is obtained of antimonious oxide, and sulphurous acid gas is evolved. The sublimate is collected in an empty globe, and the sulphurous acid is absorbed by passing it into a large vessel containing lumps of wood-charcoal. At the conclusion of the experiment the contents of the combustion-tube may be poured out, when a button of metallic antimony free from sulphur is obtained.

By passing oxygen over lumps of pyrites contained in a heated combustion-tube, vivid combustion takes place, much free sulphur sublimes, and sulphurous acid gas is obtained and absorbed as before described.

On the Presence of Nitrogen in Steel, by Alfred H. Allen.—The author made some preliminary experiments on the subject in 1872, but has only recently obtained any definite results. The method adopted has been to dissolve the steel in hydrochloric acid, by which means any combined nitrogen may be presumed to be converted into ammonia. The solution obtained was then distilled with excess of lime, and the distillate examined for ammonia by Nessler's method. The employment of this extremely delicate test enabled the author to operate on a much smaller quantity of steel than was employed by previous investigators. Very special precautions were taken to obtain the hydrochloric acid and other materials free from any trace of ammonia or nitrous compounds, and the air was entirely expelled from the apparatus before commencing the operation. The hydrogen evolved was freed from any traces of ammonia by passing it through a tube filled with glass beads moistened with hydrochloric acid. It was proved by blank experiments that no source of ammonia existed in the reagents or apparatus.

When absolutely pure materials were used, and every precaution taken to get rid of the contained air and other sources of error, the addition of Nessler's solution to the liquid obtained on distilling with lime caused a very marked yellowish-brown coloration.

The author then gives the amount of nitrogen determined by his method in different varieties of steel.

In order to obtain ammonia in quantity sufficient for its recognition by other reactions than that with Nessler's test, the following plan was employed:—

Steam, generated by boiling water in a flask, was passed over a considerable quantity of steel borings contained in a combustion tube which was bent beyond the furnace, and prolonged so as to form the inner tube of a Liebig's condenser. To the further end, a tube filled with glass beads and furnished with a glass stopcock was attached. A rapid current of steam was driven through the apparatus for a considerable time to expel every trace of air. On condensing the steam it was found free from any trace of ammonia. The steel borings were then heated to redness by a combustion furnace, and a rapid current of water passed through the condenser. The condensed steam, when tested by Nessler's solution, was found to contain abundance of ammonia, which did not diminish in amount till the borings were almost entirely oxidised. On redistilling the condensed steam, a distillate was obtained, having a distinctly alkaline reaction to litmus paper, and on treating it with hydrochloric acid and platinic chloride a sensible amount of yellow precipitate was obtained, having the characteristic crystalline form of ammonium chloroplatinate. The amount found was larger than could possibly have been produced had the whole of the nitrogen of any residual trace of air been converted into ammonia.

The author regards the results now recorded as preliminary merely, and proposes to extend the research to various classes of steel and iron, and especially to such specimens as have been found to possess anomalous characters. Of these, the evolution of ammonia from freshly fractured surfaces is the most striking.

On the Separation of Phosphorus in Steel Manufacture, by Thomas Blair.—He said the complete removal of phosphorus from pig-iron is of the utmost importance to this country, as the greater portion of ores raised and iron made here is unfit for the manufacture of steel by the Bessemer processes. A history of the various processes made use of for the purpose were examined in detail, especially the processes of Messrs. Bell, Thomas, and Gilchrist. The writer concluded that this latter process was in a fair way to succeed commercially, and that it seemed only necessary to effectually remove a few remaining difficulties.

SECTION C—GEOLOGY

On the Coal Fields and Coal Production of India, by V. Ball, M.A., F.G.S., of the Geological Survey of India.—The coal-bearing rocks of Peninsular India are all included within the limits of the great series of plant-bearing rocks to which the term Gondwana has been applied, and they are further limited to two groups of rocks which occur in the lower portion of that series.

By some authorities the age of these Gondwana rocks is supposed to be equivalent to that of the European formations which range between and include the lower oolite and the base of the trias (Buntsandstein). By others the lower measures, including the coal, are believed to be palæozoic. The author proceeded to give an outline of the recent discussions on this subject, referring particularly to Mr. W. T. Blandford's judicial summary of the evidence in the lately issued "Manual of the Geology of India."

The distribution of the coal-bearing areas was then pointed out on a series of maps which were exhibited, and the number of distinct coal-fields was stated to amount to about thirty. Some details were then given regarding these fields, of which five only are worked at present, namely, Ranigunj, Kurhurbali, and Daltongunj in Bengal, and Mopani and Warora in the Central Provinces.

The total area of the Indian coal-fields is estimated by Mr. Hughes at upwards of 30,000 square miles. Three countries alone contain larger areas, viz., the United States 500,000, China 400,000, Australia 240,000.

In quality the Indian coals are inferior to the average of English and Australian; but they are capable of accomplishing good work in locomotives, and for this purpose they are largely employed on the main lines of railway in India—Indian coal mixed in equal proportion with English.

The author proceeded to give further details as to the quality of the coal, stating that the anthracite varieties were rare, the general character being bituminous and the structure laminated—bright and dull layers alternating.

In round figures it may be stated that at present 1,000,000 tons of coal are consumed in British India *per annum* in locomotives and factories, the quantity employed in the form of coke for domestic purposes being inconsiderable; and that of this 1,000,000 tons, about one-half is raised from Indian mines, the other coming from England, France, and Australia.

On the Keuper Beds between Retford and Gainsborough, by F. M. Burton, F.G.S.—After describing the general position of

the beds in relation to the triassic system, and remarking on the absence of the upper mottled sandstone, as well as the "Muschelkalk," in this part of England, the author described the various strata of the district, as shown on the line between Retford and Gainsborough, and pointed out the want of any division in the beds of the lower keuper sandstone, as in other localities, and the absence of any boundary line between this series and the "red marls" above.

On a Northerly Extension of the Rhætic Beds at Gainsborough, by F. M. Burton, F.G.S.—At the meeting of the British Association at Nottingham in 1866, the author announced the discovery of beds of the rhætic age at Gainsborough, a full account of which will be found in the *Quarterly Journal* of the Geological Society for 1867. These beds occur to the south of Gainsborough, on the Great Northern line between Doncaster and Lincoln, and were discovered through the lowering of the gradients of that line in 1866. The author has since found them in a cutting of the Manchester, Sheffield, and Lincolnshire Railway at Blyton, about five miles to the north of Gainsborough, where they must have been exposed since the making of that line in the year 1848, though hitherto they have remained unrecorded.

The Age of the Penine Chain, by E. Wilson, F.G.S.—In this paper the author combated the generally accepted view of the post-Permian origin of the Penine chain, and contended for a pre-Permian upheaval. In support of this opinion the following facts were cited: The Yorkshire coal-basin was admittedly pre-Permian, for north of Nottingham the magnesian limestone everywhere overlaps the coal measures; but the axis of this basin is parallel with the Penine chain, and was evidently determined by the same series of movements that upraised that chain. The Permians disappear on the west in approaching the Penine chain; in this direction also the marl slates attenuate, and these and the magnesian limestone become more sedimentary, as if approaching a margin. Mountain limestone pebbles occur in Permian breccias on one or both sides of the Penine axis. Many fragments of carboniferous rocks occur in lower Bunter sandstone (breccias) on the borders of Notts and Derbyshire; but the author finds no fragments of Permian rocks in these breccias. No outliers of Permian rocks are found at any distance west of the magnesian limestone escarpment between Nottingham and Northumberland. The character and succession of the Permians on the two sides of the Penine chain are very dissimilar.

On Geological Episodes, by J. F. Blake, M.A., F.G.S.—Geological nomenclature was first founded on the theory of universal deposits; then the idea of lateral changes was introduced, with the necessary misuse of lithologically descriptive names; ultimately all deposits were seen to have their boundaries. Beds deposited in distinct areas can thus be proved only homotaxial, and these are by no means necessarily synchronous. The object of this paper is to show that a somewhat similar principle ought to govern all our geological classification. A single area is defined to be one over which we can trace one or more related formations consecutively, and which formations contain identical characteristic fossils. Deposits in single areas may be compared as to time and divided into life zones; but these in different areas are homotaxial only. In each single area the outlines and characters of the several deposits must first be determined and denoted accordingly.

In studying any group of rocks in a single area it is seen that some members have a much wider range than others. Such differences in range are accompanied by marked differences in character and point to differences in the circumstances of deposit. The wide-spread formation indicates uniform changes of level over the area and a mixture of deposits—such circumstances may be called normal. But mere local changes may bring more restricted areas into peculiar physical conditions. Such local changes may be called "geological episodes," and they will result in the formation of deposits of marked character easily distinguishable from the normal.

The first point is to determine the characters by which an episodal deposit may be differentiated from a normal one. The supreme test is that derived from its definition, *i.e.* its local development; but if it be very small, it may be insignificant; if relatively very large, the distinction may be of no consequence. As a rule argillaceous rocks are normal, and arenaceous and calcareous episodal; but this is by no means universal. When the normal formation of a period is determined, the episodes are marked by their differing mineral nature. The two kinds of deposits may also be determined by the nature of their fossils, after we have first discovered what kinds of fossils are usually episodal. For this purpose those fossils which are found in all kinds of rocks, and therefore appear to have been indifferent as to their physical surroundings, may be called *invariant*, and those found only under particular conditions, and which change their locality as these conditions change, *covariant*. Invariants only are suited for zonal classification; covariants are characteristics of episodes. A table is drawn up showing the classes, families, and genera which may be covariant, according to the imperfect observations of the past. The chief covariants are a few foraminifera—the sponges—a large number of hydrozoa and actinozoa, some crinoids, the blastoids, a few lamellibranchs, and at least half the gasteropod families.

The main proposition is that *similar, but distinct episodes, in a normal series of strata are neither necessarily nor probably of the same age.* The true method of geological classification is therefore to arrange only the normal deposits in a series by their stratigraphy and their invariant fossils, while the episodes are put in their place as such.

These doctrines applied to British strata yield the following results: No episodes are recognised in Cambrian or pre-Cambrian rocks. In the lower Silurian, the Durness limestone, the Llandeilo flags, the Bala limestone and the Caradoc sandstone, and the May Hill and Llandovery beds are characterised as such. Hence the term "Caradoc" is inapplicable as a name for the normal portion of the series. The "Colonies" of Barrande may be episodes recurrent on the same area. In the upper Silurian, the Wenlock and Aymestry limestone, the Denbigh grits, and tilestones are episodes. The carboniferous series present us with the Coomhola grits, Burdie House limestone, Millstone, and Pennant grits, while the mountain limestone is merely a gradually changing normal deposit. The episodes of the Permian are the fossiliferous limestone and underlying marl slate. The absence of the Muschelkalk from England is not regarded as due to its being an episode, but to our deposits as a whole being formed in a distinct area, the true episodes of the period being the Hallstadt, St. Cassian, and Dachstein beds. The lias is remarkable for its great freedom from episodes, which accounts for the success of its zonal classification, the only exceptions being the Sutton series, and some of the middle lias rock beds. The lower oolites, on the contrary, are almost entirely episodal, none of the beds having a wide range. The Yorkshire deposits were formed in a distinct area, and may cover the period of the great oolite as well as the inferior oolite, the deposits supposed to connect them with the latter being episodes. The rocks above the Cornbrash formed one connected series, as recognised by all German writers and some French, in which the Kelloway rock, the Corallian, and the Portland rocks are well marked episodes in this country. It is therefore suggusted that the term "middle oolites" should be abolished from the classification of British strata, and the whole be known as upper oolites. The various episodes in this series on the Continent and in England will never be truly located until their real character is seen, and it has been by the study of these rocks that the doctrine of episodes has been suggested.

In the cretaceous series the wealden, the Tealby series, and parts of the lower greensand are episodal, the ironsands being the nearest approach to a normal formation. The upper greensands are also episodes; but the chalk, though calcareous, is normal.

The lower tertiaries, like the lower oolites, scarcely present any normal deposits, the London clay being, though argillaceous, episodal in character.

In the result, the series of sedimentary rocks should be represented not by so many parallel lines, but in many cases by lenticular masses, whose age is denoted by their position—according to a table which presents their true character. It is urged, therefore, that the names proposed—or else some better—be used to distinguish the different kinds of strata and fossils, in order to give definition and importance to truths which must have long been floating in the minds of geologists.

The Surface Rocks of Syria, by J. Perry.—The paper was suggested by an examination of the sandstone quarries at Baalbec. The rock is composed of a mixture of the particles of limestone from the coast, and drift-sand. The mixture is consolidated layer by layer, and fresh rock of the same nature is now in process of formation. The author explained how the consolidation is produced by water dissolving the particles of carbonate of lime and by alternations of temperature. The author then gave some explanation of the veined and apparently cracked appearance of certain limestones.

On the Bone-Caves of Derbyshire, by Prof. W. Boyd Dawkins, M.A., F.R.S.—The first cavern discovered was that at Wirksworth in 1820, accidentally come upon in the workings of a lead-mine. Elephants, rhinoceri, &c., were found there. In 1875 the Rev. J. M. Mello explored the caves at Creswell Crags, which have yielded most important results. Amongst the bones found are those of hyæna, bison, reindeer, lion, hippopotamus, and bear, together with implements of flint and chert, and an engraved bone showing a sketch of the horse. The caves yield evidence of improvement in the manufacture of implements in succeeding dates. In 1876 Prof. Dawkins and Mr. Rooke Pennington explored the Windy Knoll, near Castleton. From the mode of occurrence of bones here, it seems clear that the bison was a summer or late-spring resident; the reindeer a winter one. A cavern near Matlock Bath was explored in 1879.

There is no evidence as to the age of these caverns; nothing to show that they existed before or during the glacial period. The author deprecated any attempt to place before the public a greater definiteness as regards the date of geological events than the facts warrant.

On Ammonites and Aptychi, by C. Moore, F.G.S.—The author gives evidence which renders it probable that the aptychus is not an operculum. It often occurs associated with numerous minute eggs; and the author suggests that, with the siphuncular tube, it probably represents an ovarian sac.

On the Classification of the British Pre-Cambrian Rocks, by Dr. H. Hicks, F.G.S.—The author divides the pre-Cambrian rocks into four groups under the following names, in ascending order:—1. Lewisian; 2. Dimetian; 3. Arvonian; 4. Pebidian.

1. *The Lewisian.*—So named by Sir R. Murchison to indicate the crystalline rocks of the Hebrides and north-west Highlands of Scotland, is retained to indicate the oldest group at present recognised in Britain, and largely developed in the Hebrides. It is found also in parts of the Malvern Chain, the north-west of Ireland, and possibly also in Anglesey. The prevailing rocks in this group are massive gneisses, in which hornblende and felspar are the chief ingredients, and quartz chlorite and mica but sparingly present. They are usually of a dusky red, grey, or dark colour. Sometimes almost a pure hornblende rock is found. The strike in these beds is usually east and west, or some point between that and north-west and south-east.

2. *The Dimetian.*—This group is largely developed in Wales, as at St. Davids, Caernarvon, Rhos Hirwain, and Anglesey. It has been found by Dr. Callaway in Shropshire, and I have recently seen it with him also in the Malvern Chain, especially in the Worcester Beacon. I noticed it also, last year, in large development at Ben Tyn, Loch Maree, and near Gairloch, in Ross-shire, as well as at several other points in the north-west Highlands of Scotland. The prevailing rocks in this group are granitoid and quartzose gneisses with pinkish, flesh-coloured, or white felspar, and with limestone, micaceous, and occasionally chloritic and hornblendic bands. Brecciated beds also occur, in which bits of the older Lewisian gneiss are sometimes found. The strike is generally north-west and south-east, or from this to north and south. It evidently overlies the Lewisian unconformably in the areas where both have hitherto been found associated; and its highly quartzose character and lighter colour generally, are in marked contrast to most of the members of that group.

3. *The Arvonian.*—At the last meeting of the British Association I mentioned, for the first time, the discovery, or rather the separation, of this group. It is largely developed in Pembrokeshire and Caernarvonshire. It occurs also in Anglesey and Shropshire, and I have recently found it at the base of the Harlech mountains. I have seen masses of it also from the Orkneys, and it probably occurs both in the Western Islands and in the Grampians of Scotland. It is the great hälleflinta group of the Swedish geologists, and the petro-silex group (Hunt) found so largely developed in North America. It is chiefly made up of quartzo-felspathic rocks, sometimes porphyritic, frequently brecciated, and of compact quartzose rocks or hälleflintas, which on microscopical examination have the appearance of incipient gneiss. The strike is usually about north and south, and it overlies the Dimetian unconformably.

4. *The Pebidian.*—This being the newest group in the pre-Cambrian rocks, is the least altered in character, and most nearly approaches in strike to the overlying unaltered or Cambrian rocks. It resembles that group in many of its rocks, and on that account was for a time supposed to be identical with it, only that it had undergone alterations. Now we know that it underlies the latter unconformably, and that the apparent similarity in character is to be attributed to the fact that most of the Cambrian rocks were derived from the denudation of this group. That it was also in a high state of alteration before the Cambrian rocks were deposited upon it is evident from the fact that an abundance of pebbles and masses of it occur in the conglomerates at the base of the Cambrian. It consists for the most part of chloritic, felspathic, talcose, and micaceous schistose rocks, alternating with massive and slaty greenstone bands, dolomitic limestone, turpentine, lava-flows, porcellanites, breccias, and conglomerates. It is traversed also frequently by dykes of granite, dolerite, &c. It is a group of enormous thickness, and is largely distributed over Great Britain. It occurs in many parts of Wales, in Shropshire, and in Charnwood Forest. I found it also last year in the north-west of Scotland, and I have seen specimens of it collected by Mr. Jas. Thomson and others from Islay, and others of the Western Islands. Dr. Hunt recognised it also along the Crinan Canal, and in the vicinity of Lough Foyle in Ireland. It is probably represented in America by the Huronian group. The prevailing strike is north-north-east to south-south-west, or from this to north-east and south-west. The conglomerates at its base are largely made up of masses derived from the Arvonian, and, at most of the points examined, it is undoubtedly unconformable to that group.

SECTION D—Biology

Department of Anatomy and Physiology

On a Visual Phenomenon and its Explanation, by Wm. Ackroyd, F.I.C. Abstract of the paper (A).—Visual phenomena are of general interest and are often described, but seldom explained. The phenomenon in question may be seen under the following circumstances. Face the breeze and without winking allow a small rain-drop to fall on the surface of the cornea, all the while keeping your gaze fixed on a lamp light some hundred feet away. As the raindrop alights on the cornea, several rings of light appear to surround the luminous source and *they gradually contract in diameter*. Explanation:

In sunshine, the moving ring-crest of water, produced by dropping a pebble into a still and shallow pool projects a ring of light on the bottom, which gradually increases in size. The moving ring-crest, by its refractive action, produces a hollow cylinder of rays of ever-increasing diameter, and we see a section of it on the bottom of the pool. The rain-drop falling on the cornea spreads out on its surface in several ring-crests, and would similarly produce a series of outward travelling rings of light were it not for the combined action of the refractive media of the eye. Under the influence of these two hollow cones of light are formed within the vitreous humour directly upon impact of the raindrop. The first of these has for its base a small circular area of the hind surface of the lens, and its prolongation; the second cone has the retina for its base. As any individual ring-crest spreads out on the cornea, the first cone increases in size, the common apex advances towards the retina, and consequently the section of the second cone projected on to the retina decreases in size and appears as a contracting ring of light.

Department of Zoology and Botany

Prof. Ray Lankester read a paper, *On a Case of Disputed Identity—Haliphysema.*—The different views of Haeckel and others on this remarkable form were discussed, and its history traced. Prof. Ray Lankester, from a careful examination of recent specimens forwarded by Mr. Savile Kent, has no hesitation in stating that it is not a sponge but a curious rhizopod-like amœba with a test of sponge spicules curiously constructed like that of a caddis worm.

Prof. Westwood, M.A., read a paper *On the Insects which Injure Books.* Referring to an address delivered by Dr. Hagen, on July 2, 1878, before the American Library Association on the same subject, Prof. Westwood passed in review the life-history of the different species of insects which have been found to destroy books and printed papers, several of which were not noticed by Dr. Hagen. The caterpillars of the moth *Aglossa pinguinalis*, and also of a species of *Depressaria* often injure books by spinning their webs between the volumes and gnawing small portions of the paper with which to form their cocoons. A small mite, *Cheyletus eruditus*, is also found occasionally in books kept in damp places. A very minute beetle, *Hypothenemus eruditus*, forms its tiny burrows within the binding of books.

Lepisma saccharina also feeds on paper, of which a very curious example was exhibited of a framed and glazed print of which the plain paper was eaten whilst the parts covered by the printing ink were untouched. White ants, Termitidæ, are a constant source of annoyance in warm climates; and Prof. Westwood also noticed the ravages committed by the cockroaches, *Blatta orientalis*.

The insects that do the greatest injury are *Anobium pertinax* and *A. striatum*, commonly known as the death watches, burrowing through the books, even, it is recorded, drilling through 27 folio volumes.

Various remedies for the destruction of these insects were mentioned and especial notice was directed to a "Report of the Commission appointed to inquire into the Decay of Wood-Carvings, and the Means of Preventing and Remedying the Effect of such Decay," issued by the Science and Art Department in 1864.

Prof. Westwood then detailed the various remedies proposed, as washing with solution of corrosive sublimates in alcohol, exposing the books to the vapour of benzine, or carbolic acid, or hydrocyanic acid, or fumigating with burning sulphur. Placing the volumes under the exhausted receiver of an air pump for an hour, has been found successful by Dr. Hagen.

The Occurrence of Leptodora in England.—Sir John Lubbock called the attention of the Section to the occurrence in England of Leptodora, a very interesting crustacean first found in deep lakes abroad, and more recently in a reservoir near Birmingham. Like many marine organisations it was as transparent as glass. This rendered the creature less conspicuous to its foes. Like other animals of the same group it laid two kinds of eggs. The young at first were quite unlike their parents, so unlike that they had been thought to be a distinct species. Sir John then entered into a description of the little animal, and by means of sketches illustrated the peculiar functions of the different organs, pointing out the difference of the organs in male and female.

On the Homologies of the Cephalopoda, by J. F. Blake.—The flexure of the intestine in Cephalopoda and Pteropoda is "pedal," and that of other Odontophora, "cephalic;" and the body of a cephalopod must be placed with the mantle cavity horizontal for comparison with a gastropod. The arms are not homologous with the foot, but form an "antivelum." The labial and tentacular processes, and not the individual tentacles of a Nautilus are shown to be homologous to the arms of an Octopod. The hood is associated with the aptychus of the Ammonite, the shell of an Argonaut, and the neckplates of a Sepia. The Ascoceras is cited to show the relations of the sepia-bone to the nautilus shell.

On Cyclops, by Marcus M. Hartog, M.A., B.Sc.—The nervous-cord of Cyclops is essentially copepodan in type, it is not dilated into special ganglia, and contains no cellular elements beyond the third thoracic segment. It bifurcates in the second abdominal segment, and the branches terminate in the furca. The sensory and motor nerves appear to be wholly distinct, the latter coming off at a higher or deeper level. All the sensory nerve-fibres pass through a bipolar ganglion cell near their distal termination. Minute rounded spaces in the hypoderm, especially one at the base of the last thoracic limb, appear to be auditory organs. Respiration in Cyclops is entirely anal.

On Mimusopeæ, a Section of the Order Sapotaceæ, by Marcus M. Hartog, M.A., B.Sc.—In this paper the genus Dipholis is merged in Bumelia, and the genera Imbricaria, Labramia, and Muriea in Mimusops: a review of the deferential characters hitherto relied on showing their inadequacy from every point of view—even convenience.

On Fruits and Seeds, by Sir John Lubbock, Bt., V.P.R.S. M.P.—Sir John commenced by calling attention to the difference presented by seeds, some being large, some small, some covered with hooks, some provided with hairs, some smooth, some sticky, &c., and after observing that there were reasons for all these peculiarities, proceeded to attempt to explain some of the more striking. In the first place, he said, many seeds required protection from birds and insects; hence the shells or husks of the beech, Spanish chestnut, horse chestnut, walnut, &c. In some cases, as in the common herb Robert, the calyx, or outer envelope of the flower opens, when the flower expands, and closes over the seeds when the flower fades, and opens again when the seeds are ripe. In other cases the flower-stalk changes its position. Thus in the dandelion, it is upright when in flower, lies close to the ground after the flower has faded, and rises again when the seeds are ripe. In the cyclamen again, the flower-stalk curls itself up into a spiral after the flower has faded.

He then called attention to the modes of dispersion by means of which seeds secure a sort of natural rotation of crops, and are also in other cases enabled to rectify their frontiers. Some plants actually throw their seeds. Thus in the common cardamine, the outer membrane of the pod becomes very tense, and when ripe, at the least touch it gives way at the base, and curling up with a spring throws the seeds three or four feet. The common geraniums also throw their seeds, and so do some of the cucumbers, but in these cases the mechanism is different. He then described the curious "elaters" of the equisetums, and other means of dispersion possessed by seaweeds, and other low organised plants. Among the higher plants, the seeds are in many cases transported by the wind. Sometimes, indeed, the whole plant is thus blown about, as in the case of the celebrated rose of Jericho, an annual inhabiting the sandy plains of Palestine, Syria, and Arabia, which when dry curls itself up into a ball, and is thus blown over the surface of the ground till it comes to a damp place when it uncurls, the pods open and shed their seed.

Many seeds are provided with a wing which catches the wind and thus aids in dispersion. Such seeds occur especially on trees, such as the pine, fir, ash, maple, sycamore, hornbeam, and many exotic species. In these cases the seeds are large, but many herbs have small seeds provided with foliaceous expansions serving the same purpose. These are sometimes so thin as to be transparent; and in *Thysanocarpus elegans*, the membrane is even perforated by a series of holes. In other cases the seeds are provided with hairs which catch the wind, sometimes forming exquisite fairy parachutes. Such for instance are the dandelion, &c., but it is curious that very different parts of the plant are modified into these hairs: thus in the dandelion and valerian it is the calyx, in the bullrush the perianth, in the willow-herb the crown of the seed, in the cotton-grass the base. In the true cotton the whole seed is covered with hairs.

Thus then, although the result is the same, the mode of arriving at it is very different. He then proceeded to the cases in which the dispersion of seeds is effected by the agency of animals. In many cases the seed is surrounded by a sweet fleshy pulp which is eaten, while the true seeds being surrounded by a tough shell, remain undigested. Such fruits are generally brightly coloured such as the strawberry, peach, apple, currant, &c., the colours like those of the flowers serving to attract animals. In other cases the action of animals is involuntary. These may be divided into two classes: those in which the seeds adhere to animals by hooks, and those in which this is effected by sticky glands. Various cases of both were cited, and specimens shown, especially the South African *Harpagophyton*, a plant whose seeds are provided with terrible hooks more than an inch long. These seeds are said sometimes even to destroy lions, they roll about on the sandy plain, and if one attaches itself to the skin, the wretched animal tries to tear it off, and getting it into its mouth, perishes miserably. Sticky seeds are also thus transported.

SECTION E

GEOGRAPHY

Opening Address by Clements R. Markham, C.B., F.R.S., F.L.S., Sec. R.G.S., F.S.A., President of the Section.

I propose to open the proceedings of this Section by attempting to place in a clear light the objects and aims of geographers, and the position which their science holds relatively with reference to the other sciences, and positively as a distinct body of knowledge with defined limits.

Geography is a knowledge of the earth as it is, and of the changes which have taken place on its surface during historical times. These changes explain to us the laws according to which similar changes are now taking place around us. The subject may be considered from various points of view; but my present endeavour will be to introduce to you, through the remarks I propose to make, the papers that will come before you to-day and at our subsequent meetings. I shall try to do this by explaining the practical uses of geographical knowledge, and its importance to us in almost every occupation in which we may be engaged.

Our first work as geographers is to measure all parts of earth and sea, to ascertain the relative positions of all places upon the

surface of the globe, and to delineate the varied features of that surface. This great work has been proceeding from the first dawn of civilisation, and it will probably be centuries longer before it is completed. Geographers and explorers, surveyors and geodesists, of each generation, work their allotted time, gradually increasing the stock of human knowledge, by enabling other sciences and other branches of inquiry to make parallel advances. For they are all dependent on the accurate measurement and mapping of the earth. Locality is the one basis upon which all human knowledge must rest. Arts, sciences, administration, commerce, depend upon accurate geographical knowledge; and as that knowledge becomes more extensive and more exact, so will every other human pursuit gain increasing light and truthfulness.

We are still very far indeed from an accurate scientific geographical knowledge of even the most civilised countries, while by far the largest portion of the earth's surface is inadequately surveyed, and a smaller, though far from inconsiderable, part is unsurveyed or entirely unknown. In the division of labour, the geodesist produces the accurate large-scale maps which are necessary in thickly populated countries, the topographical surveyor furnishes less exact maps of more thinly peopled and less civilised regions, while the trained explorer forces his way into the unknown parts of the earth.

From the labours of these three classes of workers we, in this generation, and our descendants for many generations to come, must be content to derive our knowledge; but in the fulness of time the whole earth will be measured and delineated as Hallamshire is now. It is to the furthering of this great work that the geographers of each age devote their energies, and its advancement will increase in rapidity, because, as men become better instructed, there will be more geographers.

The construction of large-scale maps on rigorously accurate principles has as yet made inconsiderable progress. It is only in the countries of Europe, and India, and some of our colonies, and in the United States, that it has been commenced. But it is very far from being completed anywhere, and the people of Sheffield have had this fact brought home to them within the last year; for the Memoir on the Yorkshire Coal Field, published by the Geological Survey in 1878, was obliged to stop short with the limits of the county, an artificial and inconvenient line which leaves the southern portion of the field undescribed, entirely because the six-inch survey had not yet been extended over Nottinghamshire and Derbyshire. This circumstance strikes us in two ways. It reminds us that geographical work is far from being completed even in the most populous and civilised parts of our own country; and it also brings the fact home to us that the progress of other sciences is dependent upon the advance of geography.

Where the trigonometrical surveys have not been commenced, we have only those maps which are based on positions fixed by astronomical observations, on cross-bearings and chained distances, and which I call (to distinguish them from the results of trigonometrical surveys) the topographical maps. One of the oldest and most interesting of these maps is the famous atlas of the Chinese Empire constructed by the Jesuits between 1708 and 1718. But we are also dependent on such maps for our geographical knowledge of all Asia except India and Palestine, of the Eastern Archipelago, of all Africa and South America, and of the greater part of North America.

Accurate maps are the basis of all inquiry conducted on scientific principles. Without them a geological survey is impossible; nor can botany, zoology, or ethnology be viewed in their broader aspects, unless considerations of locality, altitude, and latitude are kept in view. Not only as the basis of scientific inquiry, but also for the comprehension of history, for operations of war, for administrative purposes, and for the illustration of statistics, the uses of accurate maps are almost infinite. M. Quetelet, in one of his well-known letters, declared that such graphic illustration often afforded immediate conviction of a point which the most subtle mind would find it difficult to perceive without such aid. Maps both generalise and allow of abstraction. They enable inquirers at once to detect and often to rectify errors, which, if undetected, would affect results and throw calculations into confusion. As an example of the use of maps for administrative purposes, the series constructed by Mr. Edward A. Prinsep, in India, is worthy of notice. They showed the agricultural tribes of a special district arranged according to occupancy of land, political and fiscal divisions, physical features and zones of fertility, productive power as influenced by rain or aided by irrigation, different kinds of soils, acres under different kinds of produce, and lines of traffic. Another most instructive series displays the State irrigation canals acting on improvable waste lands, the depth of wells, the rainfall and zones of drought, and the parts of the country already irrigated. As another noteworthy instance of the use of maps for statistical illustration, I may mention the interesting "Carte agricole de la France," by M. Delesse, which not only shows the extent of arable, meadow, and vine lands, and of woods, but the relative value of lands by shades and contour lines of equal revenue. The idea has been adopted by Mr. Ralph Richardson in his map of Mid-Lothian showing the annual rentals by colours; and of course the colours also indicate the positions of barren mountains, of fertile valleys, and of centres of population. Such maps ought to be far more extensively used than is now the case, for in no other way can economic and industrial facts be so lucidly and clearly, as well as so rapidly, impressed on an inquirer's mind.

The third division in which geographical delineation is classed is that comprised in the labour of pioneer-exploring and discovery. This branch of our subject excites the most interest, because the heroic devotion and gallantry of our travellers is a source of just pride to the nation; and because their perils and hardships, their adventures and discoveries surround them with a halo of romance. Yet these romantic associations are not confined to the pioneers of geography. Though less known, they equally belong to the more scientific geodesist. In the whole range of exploring narrative there is nothing more calculated to excite admiration, nothing more touching, than the devotion of Colonel Lambton, the first superintendent of the Great Trigonometrical Survey of India, the old man who was absorbed in his great work for half a life-time, who wasted away from exposure and hardship, but who, to the last, brightened up to renewed animation and vigour when the great theodolite was before him, and who died at his post in a wild part of Central India. This was sixty years ago, but quite recently the equally heroic death of Captain Basevi was recorded. At 17,000 feet above the sea, in a temperature below zero, and protected only by a light tent, this martyr to science was engaged in the delicate operation of swinging the seconds pendulum. One morning, when gallantly striving to rise from a bed of suffering and to recommence work, he died. Nor do these names stand alone. Assuredly, the more scientific surveyors run equal risks, and deserve equal recognition with their exploring brethren. Still the interest justly attaching to new discoveries naturally commands most popular applause, and the importance of opening up an unknown country cannot well be exaggerated.

In this glorious field there are still harvests to be reaped through the bravery and endurance of future travellers. In spite of all that has recently been done in Africa, there is a vast unknown tract to be discovered. In Asia, in New Guinea, in Sumatra and Borneo, in South America, wide regions also remain unexplored. Above all, the greatest problem of this age awaits solution in the far north, and will call forth the best scientific ability, and all the highest qualities of our naval explorers.

Every year new regions are brought within our knowledge, and we are able to welcome the adventurers home, and to add them to the list of geographical worthies. But, with regard to many explorers, there can be no doubt that much more valuable information might be obtained than is now the case. Men, with various avocations, traverse unexplored or little known countries, who, from want of previous training are unable to lay down their routes or to observe with scientific accuracy and intelligence. There are naval and military officers, missionaries, consular agents, colonial officials and planters, engineers, telegraphers, collectors, and sportsmen or persons merely travelling for pleasure, many of whom are led, by business or curiosity, to penetrate into regions of which little is known. It is most important that there should exist, in this country, the ready means of furnishing the necessary training to such explorers; and the subject has recently received serious consideration from the Council of the Royal Geographical Society.

It has been resolved that a course of instruction shall be supplied by the Society to all who are about to visit unknown or little known countries, and who desire such training. As a preliminary measure, the present arrangement is to give such instruction as will enable the pupil to fix positions by astronomical observations, and to lay down his route; but this is only a beginning, and it is to be hoped that, in due time, such a course of instruction will be provided as will enable an intelligent

traveller to observe with scientific accuracy, and to bring home really valuable results in various branches of inquiry. It is very desirable that this resolution of the Geographical Society should be widely known, and I trust that the local members of this section will co-operate so far as to bear in mind that this aid is offered by the Geographical Society, when the intention of any native of Hallamshire to visit a distant region comes to their notice. Incalculable good may be done to the cause of geography by a system which will have the effect of making every traveller a scientific and intelligent observer.

The surveying and mapping of the ocean is only second in importance to that of the land; and this work also divides itself into three sections, namely, the coasts surveyed, the coasts partially surveyed, and the unsurveyed coasts. Hydrography will not be completed until all the coasts in the world are included in the first section, which is now very far indeed from being the case. Yet this is not merely a question of science, of the study of the physical geography of the sea, interesting as this branch of our subject has become. Upon the accuracy and completeness of charts hangs the safety of thousands of lives, and the prosperity of commerce in all parts of the world. When it is remembered how much depends upon the work of marine surveys, it must be a subject of astonishment that so many hundreds of miles of coast line frequented by our shipping remain unsurveyed; and that even, in some cases, when the surveys have been executed and charts published by foreign governments, they are not accessible in an English form. In the interests of humanity and of the well-being of our trade, the efforts of geographers in urging the completion of marine surveys ought to be cordially seconded by Chambers of Commerce, and by all those whose material interests are concerned in the provision of accurate charts of all coasts visited by our shipping.

Hitherto I have invited your attention to the basis of geography, to the measurement of the surface of land and sea, and of their heights and depths; to the mapping of the world, and to the innumerable uses of maps and charts. But this only forms the skeleton of our science, which is endued with flesh and blood, with life and motion, by those who study the causes and nature of the changes that have taken place and are now taking place upon the earth; by comparative and physical geographers, by those who study and classify natural phenomena, and demonstrate their connection with each other and their places in the great scheme of nature.

Geography and geology are, from one point of view, sister sciences. The former treats of the earth as it now is and of changes which have occurred within historical times. The latter deals with the condition of the earth and the changes on its surface which went on during the cycles of ages before the dawn of history. The two sciences are quite distinct, while they aid each other. No geological survey can be undertaken without the previous completion of geographical maps, and the geologist is enabled to comprehend the condition of the earth in remote ages by studying the phenomena of physical geography. On the other hand, the geographer acquires a correct understanding of the present state of the earth's surface by considering the records of those marvellous changes which can be gathered from history and from the narratives of travellers and observers in all ages. Without their services, geography would lose half its interest.

Comparative geography (the study of the changes which have taken place on the earth's surface within historical times) is, therefore, a most important branch of our science; and it enlists the historian and the topographer in our service. It is a branch of geography which has not hitherto received the amount of attention it deserves.

The importance of the study of history and of early narratives for the elucidation of points in physical geography will appear from the consideration of a few instances. Take for example the great and fertile basin of the river Ganges in India. The Sanscrit historian finds reason for the belief that in 3000 B.C. the only habitable part of the alluvial plain of India was the water-parting or ridge between the Sutlej and the Jumna. The rest was a great estuary or arm of the sea. It has only been fit for man's occupation within the historical period, and hundreds of square miles of the delta have become habitable since the days of Lord Clive. The wonderful history of these changes can be traced by the student, who thus enables the geographer to explain the phenomena which he observes. Mr. Blanford, in his charming work on physical geography for the use of Indian schools supposes a native of the country to be standing on the bank of the river that flows by his village, watching the turbid flood swirling past. The *chur* opposite, which the river left dry when its waters fell at the close of the last rainy season, and which, till lately, was covered by a rich green crop of indigo, is now more than half cut away, and buried beneath the water. Masses, many times larger than the house he lives in, from time to time detach themselves, and are swallowed up by the deep muddy stream. If the Hindu ponders over what he sees he will perhaps be led to make inquiries, and old people will probably tell him that half a century ago the river itself was a moderate-sized *khall*, and that the old channel, seven or eight miles off, now little more than a string of pools, was at that time a great river. These facts and their causes will open to him an interesting chapter in physical geography; which is made more complete and more interesting by the ancient records of his people. But geography is an applied science. This body of facts and their causes is not a subject for mere speculative study only. It is of practical utility; for the knowledge of the way in which Nature has worked in past ages discloses her present and future operations, and enables the enlightened administrator and engineer to work in harmony with them.

Again, to pass to another part of the world. The student of history reads of the great sea fight which King Edward III. fought with the French off Sluys; how, in those days, the merchant vessels came up to the walls of that flourishing seaport by every tide; and how a century later a Portuguese fleet conveyed Isabella from Lisbon, and an English fleet brought Margaret of York from the Thames, to marry successive Dukes of Burgundy at the port of Sluys. In our time if a modern traveller drives twelve miles out of Bruges across the Dutch frontier he will find a small agricultural town surrounded by corn fields and meadows, and clumps of trees, whence the sea is not in sight from the top of the town-hall steeple. This is Sluys. A physical geographer will seek out the causes which have brought about this surprising change. They are most interesting, and most conducive to an intelligent comprehension of his science, and he will find them recorded in history. Thus the historian and the geographer work hand in hand, each aiding and furthering the researches of the other.

Once more. We turn to the great Baie du Mont Saint Michel, between Normandy and Brittany. In Roman authors we read of the vast forest called "Setiacum nemus," in the centre of which an isolated rock arose, surmounted by a temple of Jupiter, once a college of Druidesses. Now the same rock, with its glorious pile dedicated to St. Michael, is surrounded by the sea at high tides. The story of this transformation is even more striking than that of Sluys; and its adequate narration justly earned for M. Manet the gold medal of the French Geographical Society in 1828.

Once again let us turn for a moment to the Mediterranean shores of Spain, and the mountains of Murcia. Those rocky heights, whose peaks stand out against the deep blue sky, hardly support a blade of vegetation. The algarobas and olives at their bases are artifically supplied with soil. It is scarcely credible that these are the same mountains which, according to the forest book of King Alfonso el Sabio, were once clothed to their summits with pines and other forest trees; while soft clouds and mist hung over a rounded shaggy outline of wood, where now the naked rocks make a hard line against the burnished sky. But Arab and Spanish chroniclers alike record the facts, and geographical science explains the cause.

There is scarcely a district in the whole range of the civilised world where some equally interesting geographical story has not been recorded, and where the same valuable lessons may not be taught. This is comparative geography.

The peasant of Bengal sees the mould falling into his turbid river, and learns the first lesson of a course which teaches him the history of the formation of the mighty basin of the Ganges. So should we, in England, to use the words of Professor Huxley, "seek the meanings of the phenomena offered by the brook which runs through our village, or of the gravel pit whence our roads are mended." Their meaning is equally significant, equally instructive, and it is thus that we should all begin to learn geography.

M. de Brazza read a paper *On his Exploration of the Ogové River*, details of which have already been published at various times in NATURE. After leaving the basin of the Ogové and crossing the watershed he came upon the Alima, a large river flowing eastwards, which he has no doubt is a tributary of the Congo.

Captain Gerald Martin had sent home, from the seat of war, a paper *On the Afghan War—the Kurum Valley.*—Captain Martin wrote from the Peiwar Kotal, and he reported on the survey operations conducted by officers of the Indian Survey Department attached to the "Kuram Column" of the Afghanistan expeditionary force. The area comprised the whole of the Kuram Valley and the district of Khost to the south, representing an addition to our geographical knowledge of 4,500 square miles. The paper concluded with a very interesting account of the botany of the Kuram Valley and of its forest-clad slopes (which was furnished by Dr. Aitchison), and with a detailed account of the Hill tribes. The inhabitants of the Kuram Valley are agriculturists and their irrigation works gave evidence of immense labour. A paper by Captain R. Beavan was read describing the country between Kandahar and Girishk.

Lieutenant St. George C. Gore described the *Pishin Valley*, which is now to be annexed by the British Government. Its extreme length is about 48 miles, and its average width including the hill ranges on either side, from 25 to 30 miles. It is a perfectly open, nearly flat, alluvial plain, with a very barren aspect owing to the absence of trees, except fruit trees in a few gardens.

SECTION F—ECONOMIC SCIENCE AND STATISTICS

Prof. Leone Levi delivered an address upon *The Scientific Societies in Relation to the Advancement of Science in the United Kingdom.*—The importance of the subject, and the renewed effort to rear a building in the Metropolis for several scientific societies, now insufficiently accommodated, had induced him to submit the paper. In the seventeenth century there were only two scientific societies in this country; but at the present time, in an age often described as wholly given to the ignoble occupation of money-making, the calendar exhibited an amount of activity quite unknown at former periods. The membership of the three Royal Societies was then mentioned, and Prof. Levi gave many interesting particulars of societies instituted for the promotion of the physical and mathematical sciences, natural history and biology, archæology and geography, the applied sciences, and instanced a large number of miscellaneous societies. Altogether, including local scientific societies, the number of members of scientific societies in the United Kingdom is about 60,000, or deducting ten per cent. representing those belonging to several societies, about 54,000 individual members. But even that could be scarcely considered as representing men of science, and probably about 25,000 persons was the number of people who had any recognised status in the world of science, or who were actually engaged in the pursuit of science within the British isles. Some facts were then given as to the income of scientific societies.

Eliminating from the total vote the amount expended for elementary education, the proportion devoted to science and art has been considerably diminished. In 1835, the Government of the day voted 65,000*l.* for elementary education, and 70,000*l.* for science and art, or a proportion of 52 per cent. for science and art. In 1878, the vote for elementary education amounted to 3,624,000*l.*, and that for science and art to 529,000*l.*, or a proportion of 12 per cent. for science and art. Further, Government aid was principally given to physical and natural science, leaving a wide range of scientific exploration altogether unassisted. Great had been the achievements of science in modern times, and England owed to its cultivators a profound debt of gratitude. Our manufactures and industry, our productive power and means of locomotion, all depended for their development on the advance of science, and these scientific societies had a high economic value. Much more, however, remained to be accomplished, and England's hope to maintain her high position in productive industry must depend on the success which men of science might attain in fathoming the inexhaustible secrets of nature, on the increase in the number of patient yet ardent votaries of science, and still more on the diffusion of education and scientific knowledge among the great body of the people.

SCIENTIFIC SERIALS

Bulletin of the United States Geological and Geographical Survey of the Territories (vol. v. No. 1. Washington, February 28).—Notes on the Aphididæ of the United States, with descriptions of species occurring west of the Mississippi, by Chas. V. Riley and J. Monell.—The relations of the horizons of extinct vertebrata of Europe and North America, by E. D. Cope.—Observations on the faunæ of the miocene tertiaries of Oregon, by E. D. Cope.—Notes on the birds of Fort Sisseton, Dakota territory, by Chas. E. McChesney.—Palæontological papers, No. 9.—Fossils of the Jura-trias of South-eastern Idaho, by C. A. White, M.D.—Jura-trias Section of South-eastern Idaho and Western Wyoming, by A. C. Peale, M.D.—Fossil forests of the volcanic tertiary formations of the Yellowstone National Park, by W. H. Holmes.—Palæontological Papers, No. 10.—Conditions of preservation of invertebrate fossils, by C. A. White, M.D.—Supplement to the bibliography of North American invertebrate palæontology, by C. A. White, M.D., and H. Alleyne Nicholson. This supplement embraces publications which have been made during the year 1878, and also all the omissions pertaining to the first list issued as No. 10 of the Miscellaneous Publications of the U.S. Geological Survey. The year 1878 was not productive of many memoirs on North American invertebrate palæontology. Dr. White records the publications made in the United States, Prof. Nicholson those made in British North America, West Indies, and Europe.

THE *Verhandlungen der k. k. geologischen Reichsanstalt, Wien* (No. 10, 1879) contain the following papers:—On a new occurrence of celestine in the Banat Mountains, by Fr. von Hauer.—On the distribution of Silurian deposits in the Eastern Alps, by G. Stache.—On a peculiar variety of the greenstone of Dobschau, by S. Roth. The peculiarity of this rock consists in its copious tenor of calcspar, beside felspar and hornblende. Apart from these principal constituents, augite, diallage, and secondary quartz are represented in the mixture. Here and there the hornblende incloses small crystals of pyrites and of nickeline.—On *Cyclocladia major*, Lindl. and Hutt., by Karl Feistmantel.—On a collection of petrifactions from the Silurian deposits made by Herr M. Dusl at Beraun, by Prof. G. Laube.—On the recent eruption of Mount Etna, by Ad. Pereira. The author gives a somewhat scanty description of an ascent he made during the last eruption, during which he actually reached the active crater.—The last paper in the number is a valuable account of an excursion into the district between the Bosna and Drina Rivers (Bosnia), by Dr. E. Tietze.

THE *Rendiconto delle Sessioni dell' Accademia delle Scienze dell' Istituto di Bologna* (1878-79).—From this part we note the following papers:—Observations on some habits of *Vespertilio murinus*, L., and on some studies in comparative anatomy connected with this animal, by Sig. Ercolani.—Notes on an ancient Phœnician skull found in Sardinia, compared to similar skulls of the present time, by Sig. Calori.—On the decomposition of salts of a volatile base and its importance in toxicological operations, by Sig. Selmi.—Note on certain fermentations at low temperatures, by the same.—Researches on the principal phases of the annular eclipse of the sun of July 19 last, partially visible at Bologna, by Prof. Saporeti.—On the ossification of the humor vitreus of the human eye, and on some other strange modifications of the same, by Sig. Ciaccio.—On the equilibrium of plane polygons of variable form, by Sig. Ruffini.—On a new hydrotacchimeter, by Sig. Cesare Razzaboni.—On some researches in analytical geometry, by Sig. Beltrami.—On the thermical and galvanometrical laws governing the formation of the electric spark in gases, by Sig. Villari.—Contributions to the fossil conchology of Italy, by Sig. Foresti.—On the excreting apparatus of *Janus cristatus* by Sig. Trinchese.—On the ossiferous breccia of the S. Teresa cave, by Sig. Capellini.—On the flora of the province of Bologna (third paper), by Sig. Cocconi.—On the history of geodesy in Italy, by Sig. Riccardi.—On a Holtz's machine of special construction, by Sig. Righi.—Chemical researches on the metamorphoses of the marbles of Carrara and of Monte Pisano, by Prof. Santagata.—On the deposits and genesis of phosphates generally and their use in agriculture, by Sig. Predieri.—On the motion of water in vessels communicating by long tubes, by Sig. Cesare Razzaboni.—On the quantitative analysis of mixtures containing alcaline sulphides, carbonates, sulphates, and hyposulphates, by Sig. Cavazzi.—On the origin of the optical nerve in the brain of fishes, by Sig. Bellonci.—On the structure of so-called cellular and parenchymatose cartilage, by Sig. Ciaccio.—On some products of arsenical putrefaction, by Sig. Selmi.—On the thermical and galvanometric laws of the induction spark, by Sig. Villari.

THE *Journal of the Russian Physico-Chemical Society* of St. Petersburg (tome xi. No. 6) contains the following papers of

interest:—On some cinchonin compounds, by M. A. Wischnegradsky.—On the origin of milk, by M. L. Schichkoff.—On isotributylene by M. A. Butlerow.—Researches on the nucleine of milk, by M. N. Lubavin.—Analysis of the water of the Oka river, as well as of the sources which supply the aqueduct of Nishnii Novgorod, by M. N. Socoloff.—On β chloropropionic aldehyde, by M. G. Krestownikoff.—On β chlorobutyric aldehyde, by M. J. Karetnikoff.—On homoitaconic acid, by MM. G. Krestownikoff and W. Markownikoff.—On the products of dry destillation of phtalate of calcium, by M. O. Miller.—On the tenor of nitrogen in the detonating nitroethers, by M. J. Tcheltzoff.—On some applications of the mechanical theory of heat to the variations in the state of an elastic body, by N. Schiller.—On the influence of hydrogen on the volumes and on the elasticity co-efficients of palladium and its alloys, by N. Hesehus.

THE *Rivista Scientifico Industriale* (Nos. 14 and 15).—From these parts we note the following papers:—On the subdivisibility of the electric light, by Prof. Rinaldo Ferrini.—Observations of Swift's comet, made at the Royal Observatory of Brera, at Milan, by Prof. G. V. Schiaparelli.—On the non-existence of nascent hydrogen and the reduction of perchlorate of potash, by Dr. D. Tommasi.—On the smallest species of the Araceæ family, by Prof. O. Beccari. The name given to the new species by the professor is *Microcasia pygmaca*.—On the presence of lithium salts in the sea-water between Pozzuoli and Castellammare, by Prof. S. de Luca.—On the synthesis of sulphuretted and seleniuretted hydrogen, by Prof. A. Januario.—On red amber, by Prof. Capellini.—On the phenomena of acoustic attraction and repulsion, by Prof. Tito Martini.—On a new seismological instrument called "Ascoltatore endogeno" (endogenous listener), constructed by Prof. Giovanni Mugna.

SOCIETIES AND ACADEMIES

PHILADELPHIA

Academy of Natural Sciences, January 7.—Description of a new species of goniobranchus, by Andrew Garrett.

January 14.—List of land shells inhabiting Rurutu, one of the Austral Islands, by A. Garrett.

January 21.—Notes on some Pacific Coast fishes, by W. N. Lockington.

January 28.—Further notes on the mechanical genesis of tooth-forms, by J. A. Ryder.—Note on hyraceum, by Drs. Greene and Parker.—Morphological notes on the limbs of the amphiumidæ, by J. A. Ryder.—The land shells of the Mexican Island of Guadeloupe, by W. G. Binney.

February 4.—Prof. Leidy on fossil remains of a caribou deer.

February 11.—On the parasol ant, by Rev. H. C. McCook.

February 18.—Structure of chimpanzee, by Dr. Chapman.

February 25.—Descriptions of three new species of calceolidæ from Upper Silurian, by V. W. Lyon.

March 11.—Nudibranchiate gasteropods of North Pacific, by Dr. R. Bergh.—On the variability of *Sphæria quercuum*, by J. B. Ellis.—Notes on *Opuntia prolifera*, by T. Meehan.

March 25.—Notes on *Amphiuma*, by Dr. Chapman.—On a new genus and species of *Scombridæ*, by W. N. Lockington.

PARIS

Academy of Sciences, September 1.—M. Daubrée in the chair.—M. Faye presented, in the name of the Bureau des Longitudes, the *Connaissance des Temps* for 1881, and mentioned the improvements introduced.—The following papers were read:—Mathematical theory of the oscillations of a double pendulum by Mr. Peirce; note by M. Faye.—Note on solar temperatures, by M. Janssen. The expression, *temperature of the sun*, is wanting in precision, and the methods of measurement adopted are faulty, in view of the want of homogeneity in the solar surface, and the vast envelopes which prevent the radiation reaching us in all its force. To conclude the temperature of the photosphere from its radiating power, one should know the emissive power (which is, however, unknown to us). The common methods may give truly the calorific force of solar radiation which reaches the earth's surface, but they give no exact notions of even an average temperature (which expression, indeed, is inapplicable to the sun). M. Janssen's efforts are now directed to a study of the sun in each of its distinct parts, employing analytical methods, and especially photography of the spectra of portions studied.—On the chemical constitution of alkaline amalgams, by M. Berthelot. The addition of solid mercury to amalgams containing already several equivalents of this metal liberates little or no heat, just as in the addition of solid water to saline hydrates, which already contain several equivalents of water; nearly all the heat or work having been developed in the previous combination. This gives a new relation between saline hydrates and metallic alloys.—On the projects of an American maritime canal, and of communication between Algiers and Senegal, by M. de Lesseps. He presented a volume of proceedings of the International Congress and reports relating to the former scheme. As to the latter, he thinks it would be well to commence by establishing telegraph stations at various points where water is obtainable.—On a means of diminishing the loss of *vis viva* in a divergent ajutage of large dimensions, the angle of which is too open, and which may be divided into several by conical surfaces having the same axis, by M. de Caligny.—On a process of obtaining in any ball governor the degree of isochronism desired, &c.; practical rules, by M. Leanté.—Anatomical and morphological researches on the nervous system of insects, by M. Brandt. *Inter alia*, it is untrue that all insects have a sub-œsophagean ganglion separate from the others (*Rhizotrogus*, *Stylops*, and *Hydromedra* have not). The circumvolutions of the brain are found in *all* insects, in various development, and the development differs in individuals of the same species. In general, the development of the hemispheres, but not of the whole brain, is related to instincts and habits. In some insects having two thoracic ganglions, the first is simple, the second compound; in others both are compound. The transformation of the nervous system takes place in some insects by reduction of the number of ganglions; in others by an opposite process.—On two new elements in erbine, by M. Cléve. The spectrum of the old erbine is attributed to three distinct oxides. The two new elements he designates *Thulium* (from Thule, the old name of Scandinavia) and *Holmium* (a derivative from the Latinised name of Stockholm).—Prof. Lawrence Smith remarked on the doubts of some *savants* as to the results of recent study of earths of the yttrium and cerium group.—Partial synthesis of milk-sugar and contribution to synthesis of cane-sugar, by M. Demole.—Reaction of tungstates in presence of mannite, by M. Klein.—On the determination of urea; reply to M. Esbach, by M. Méhu.—On the physiological effects of formiate of soda, by M. Arloing. It lowers the animal temperature, accelerates the respiratory movements, &c., is poisonous when the dose exceeds 1 gr. per kilog. of weight of the animal. It might be advantageously used for salicylate of soda in some cases.—On some facts relating to contraction, by MM. Brissand and Richet.—Morphological and zoological researches on the nervous system of dipterous insects, by M. Künckel.—On the plurality of nuclei in certain plant cells, by M. Treub.

CONTENTS

THURSDAY, SEPTEMBER 18, 1879

COLOUR-BLINDNESS

Colour-Blindness, its Dangers, and its Detection. By B. Joy Jeffries, A.M., M.D., Ophthalmic Surgeon. (Boston, America: 1879.)

SOME months ago the subject of colour-blindness was introduced into the columns of this periodical as bearing on a question of colour nomenclature. Little was then said on the subject itself beyond what was necessary to illustrate the point in dispute, but it may now be added that the general features of this remarkable defect of vision have lately been exciting much attention, and have given rise within the last few years to a somewhat extensive literature, involving points on which there has been much difference of opinion and some energetic controversy.

It is just a century since the first public announcement was made, through Dr. Priestley, of a case of defective vision, which, by the account left on record, we can easily recognise as being of the kind subsequently found so common. About twenty years later we come on the well known and often-quoted description of his own case, given by John Dalton, which, after another lapse of thirty years, was commented on by Sir John Herschel in a very lucid and instructive manner. This celebrated case has given rise to the name "Daltonism," by which the complaint is most generally designated by Continental writers, but which has been objected to by the English, on the ground that it is no compliment to their great chemist to associate his name with an unfortunate natural defect in his optical apparatus. Many other words, chiefly derived from the Greek, have been from time to time proposed, but the simple term *colour-blindness*, adopted generally by English writers, and its equivalent, *Farbenblindheit*, used by the Germans, appear to answer every purpose, and to be unobjectionable. For, whatever may be the special characteristics of the defect (and on this point there are differences of opinion), it is admitted on all hands that an inability to appreciate the sensation conveyed by some particular colour or colours to the normal eye must be its most distinguishing feature.

In 1840 appeared an essay by Prof. Elie Wartmann, of Lausanne; but the first complete work on the subject was the "Researches on Colour-Blindness," by Dr. George Wilson, of Edinburgh, published in 1855. After this several memoirs are to be found, chiefly in transactions or journals; but the subject attracted little notice beyond mere curiosity, till a few years ago, when oculists and physiologists suddenly woke up to a conviction that it had a real importance, both theoretical and practical, and therefore deserved more careful study than it had yet received. This movement appears to have originated in a more vivid appreciation of certain dangers that were considered likely to arise from the employment, in railway and marine service, of persons who were colour-blind, and were consequently liable to mistake coloured signals. This danger had been clearly pointed out by Prof. Wilson, but it had required many years for its importance to become recognised. When, however, attention was roused, there was no lack of persons ready to undertake the investigation of the subject, and a host of works have appeared by many men of eminence proposing means of providing against the evil; and although the inquiries have been instituted at first with chiefly a practical bearing, they have naturally, in the hands of scientific men, been mixed up with a good deal of speculation of a more theoretical kind. Among the workers who have busied themselves with the subject may be mentioned Prof. Holmgren, of Upsala, in Sweden; Dr. Stilling, oculist at Cassel; Dr. Magnus and Prof. Cohn, of Breslau; Prof. Donders, of Utrecht; Prof. Ewald Hering, of Prague; Dr. Daae, of Norway; Drs. de Wecker and Landolt, of Paris; and Professors Delbœuf and Spring, of Liege. Unfortunately, although we know that some of our most eminent oculists in England have also lately had the subject under their consideration, their researches have not yet been made public, and it is, therefore, opportune that we are able to announce the appearance of a work which, although not by an Englishman, is in our language, and will, therefore, make the English reading public acquainted with what has been done.

The author is ophthalmic surgeon to several hospitals; he is otherwise much connected with ophthalmological matters, and has had large experience in regard to colour-blindness. He gives a good and full account of the general nature and statistics of the defect, and the means he considers best calculated for its detection; enlarging on the necessity for a systematic testing of the vision of servants on railways and sea-going vessels, and recommending the rigid exclusion of those who have imperfect colour-vision. He further devotes some attention to matters of theory, adopting and advocating the views most generally entertained.

It is impossible, in the short space of such a notice as the present, to give any extended analysis of the recent comprehensive investigations; it must suffice to make a few remarks on some of the more prominent points of interest; and first as to the statistics. Dr. Jeffries has some interesting chapters on this head, and states that variable statistics have been given by different observers, depending largely on the mode of testing.

In regard to males, he gives a table of the results obtained by eleven different observers, who had examined on the aggregate about 50,000 persons, chiefly pupils in schools, *employés* on railways, soldiers, or sailors. The proportion of colour-blind persons was given variously from 3 to 6 per cent., the average being about 4. Assuming, therefore, the examinees to represent fairly the general population, we may take it for granted that one out of every twenty-five men we meet is deficient of any true ideas respecting the colours of objects he sees around him.

With females, the case is very different, the defect in that sex being exceedingly rare. Out of nearly 20,000 women and girls examined, there were only registered forty cases of colour-blindness, or 0·2 per cent.; and some of these are of doubtful accuracy. This is a very singular fact, for which no sufficient explanation has ever been suggested; it has indeed been remarked that women devote much more attention than men to colours in general, but this has no bearing on the question, inasmuch as the evil is not a functional derangement, which

might be brought right by exercise, but a natural and congenital defect of organic structure, altogether incapable of cure or even amelioration by any means at present known.

There is every reason to believe the defect is hereditary, and Dr. Jeffries gives some data as to its transmission, showing the curious law (not, however, without exceptions) that it is transmitted *through* the females, although the females themselves escape it, thus skipping over every other generation. For example, if a man is colour-blind he will have no colour-blind children, neither will any of his sons' sons be colour-blind, but the defect will probably be found among the sons of his daughters.

It has been asserted by some authorities that a higher percentage of cases exists among people of the Jewish faith, and an ingenious question has been raised whether this may not indicate a descent from an early general type of imperfect vision, so giving a sort of support to the Gladstonian theory of development of the colour-sense. But as the fact is disputed, it is useless to trouble ourselves about any inference from it.

Another point of interest is the mode of testing and examining the colour-blind, and a large portion of Dr Jeffries', as of all other late works, is devoted to this matter. There are two distinct objects in view in such examinations: first, simply to discover whether the examinee is or is not colour-blind; secondly to find out the precise nature of his sensations of colour.

The first is of the more practical importance, and it is aimed, of course, chiefly at the testing of railway servants and others who have to do with colours. I hold a strong opinion that too much alarm has been created about the danger of mistaking railway signals. Normal-eyed people (who have always the greatest difficulty in comprehending what the colour-blind really see) generally believe that because under certain circumstances a red and a green object give similar impressions to a Daltonian, therefore he must, under all circumstances, confound redness and greenness. Nothing can be further from the truth, and I may give my own experience with railway signals as an example. I have had a great deal to do with railways, and although there can be no doubt about my colour-blindness, I do not recollect that I ever experienced any difficulty in distinguishing a red lamp from a green one. They are always strongly contrasted to my eye, and often, when I have passed at night through Cannon Street Station, I have amused myself by watching the changes in the imposing array of signals exhibited there. I could give a sufficient explanation of this, but it would be out of place here. I believe, so far as my knowledge at present goes, that nearly all colour-blind patients see the distinction as well as I do; and this view is corroborated by the great fact that, although we may assume that down to a late period about one out of every twenty-five engine-drivers has been colour-blind, never since railways have been in use has a single accident occurred which has been positively attributable to the mistaking of a red for a green night signal. If the notions of the alarmists were well founded, we should have had collisions every day. At the same time I do not deny the possibility of danger, under certain circumstances, and I would by no means discourage the precautions proposed in the selection of men.

It is not so easy a matter to identify positively a case of colour-blindness as might at first be supposed. Mere inaccuracy in naming colours is not sufficient, for it often happens, on the one hand, that normal-eyed people name colours incorrectly, and, on the other hand, that colour-blind people will name many colours correctly. There have been several kinds of tests adopted by different examiners, but the most important are those by Holmgren, Schilling, and Daae. The first is the one recommended by Dr. Jeffries, and it is described by him at considerable length. The test is made with a large number of samples of worsted (or what we call Berlin-wool) of a great variety of colours and shades. A certain sample, of a pale but decided tint of green, is shown to the patient, who is desired to select from the heap all the specimens which, to his eye, match it in colour. If he is normal-eyed he will select only green samples, but if he is colour-blind he will add others of other colours, such as pink, light-brown, gray, &c., which, though so different to the normal-eyed, match the green tint to his defective vision. But the wools have to be carefully selected, and are expensive. Dr. Schilling's test consists of a set of lithographed coloured diagrams; he takes two colours which, though normally strongly contrasted, he knows appear alike to the colour-blind, say scarlet and yellow-brown, and he draws letters or patterns in one of these, on a ground of the other, *i.e.*, a scarlet pattern on a brown ground, or *vice versâ*, the design being so ingeniously arranged as to avoid betraying any lines of division. A single glance at these diagrams by a colour-blind person suffices to test his vision. If he is normal-eyed the patterns are visible to him; if he is colour-blind they are invisible, the whole diagram conveying to his mind the idea of one uniform colour.

Dr. Daae's test is a little page of samples of coloured worsted, arranged in rows. Some of the rows are devoted each to one colour, arranged in different tints and shades, while other rows contain different colours in the same row. If the patient is unable to distinguish between these two classes he is colour-blind.

All these tests are very simple, and appear to be efficient so far as the mere detection of the fact is concerned, which is all that is wanted for economic purposes.

But some of the investigators go farther; they prescribe other tests with a view to find out what is the nature of the patient's vision—to get an idea of what he actually sees. The arrangements proposed for this purpose are much more elaborate. Holmgren, for example, exhibits other samples of wool, and endeavours to infer the nature of the vision by observing what colours are considered to match it. Schilling has different sets of diagrams for what he considers different classes of the complaint, while many other contrivances, some of them extremely complicated, have been designed to test the vision by shadows, by coloured glasses, by reflected images; by polarisation, by contrast, by comparisons, and by the spectroscope. These are all more or less unsatisfactory, and the information hitherto obtained by them is worth very little. The answers of the patients are seldom trustworthy, and they are almost always interpreted by the examiner to suit some preconceived theory of his own. One of the most earnest and industrious investigators, Dr. Cohn, gives a long list of answers he has

received, but he has unfortunately vitiated his whole work by relying to a large extent on the naming of colours by the patients. This is the very worst and most fallacious test of all, and Dr. Jeffries quotes, in reference to it, the following forcible remarks by Helmholtz :—

"As to the examination of the colour-blind, simply asking them to name this or that colour will naturally elicit but very little, since they are then forced to apply the system of names adapted to normal perception to their own perception, for which it is not adapted. It is not only not adapted, because it contains too many names, but in the series of spectral colours *we* designate differences of tone [hue ?] as such, which to the colour-blind are only variations of saturation or luminosity."

My own experience enables me thoroughly to corroborate this : if any one asks me to name a colour shown me, I tell him it would be as reasonable to treat me as a clairvoyant and to expect me to read the contents of a sealed envelope.

But these inquiries, as above stated, always have to do with the *theories* of colour-blindness, and a few words must be said on this point, which is one of great difficulty, and in regard to which the state of knowledge is at present exceedingly unsatisfactory. When Dalton wrote what may be considered the first good account of the defect, he, notwithstanding his great acuteness and his extraordinary powers of scientific investigation, failed to discover the important point of his case, namely, that he saw *two colours only*—yellow and blue. This was found out for him at a much later period by the penetration of Sir David Brewster and Sir John Herschel, who designated the malady by the term, *dichromic vision*, which has ever since been used. Sir David Brewster, acting on this, framed a very simple explanation of the defect, founded on his own views as to the nature of colours. He had a theory that the solar spectrum was formed from three separate spectra overlapping each other, one giving red light, one yellow, and one blue, which might therefore be considered the three primitive colours for normal eyes, as it was taken for granted all other colours might be compounded from them. All that was necessary for the explanation of colour-blindness was to assume the eye of the patient insensible to the red rays, and the phenomena followed as a matter of course. This theory was a very plausible one, and is still in favour with many persons who have practically to do with colour. But unluckily on further examination it was found wanting, inasmuch as one of the main effects in it, namely, the supposed production of green by a mixture of yellow and blue, turned out to be a delusion ; and moreover, as the theory of light became better known, the idea of overlapping spectra was abandoned, it being clear that every hue of colour had its own peculiar generating wave. Hence Brewster's elegant and simple explanation of colour-blindness fell to the ground.

Some years afterwards came out what is called the "Young-Helmholtz" theory, which assumes that the normal visual organs are capable of being impressed with three colour sensations, corresponding to red, green, and violet, and that all colour-perception is caused by the combined action of these in varying proportions. It is then assumed that in colour-blind people one of these sensations is wanting, leaving only the other two in action, and thus causing dichromic vision. The most common defect is supposed to be blindness to red, and on this hypothesis the colour-blind ought to see only violet and green. At the same time the supporters of this theory fancy they can detect some cases where the green is wanting, leaving only red and violet, and others where the violet is wanting, leaving visible only the red and the green.

This theory is in great favour, owing to the eminence of its authors and the support of many distinguished physicists ; and it is adopted implicitly by Dr. Jeffries. But objections have been raised to it on several grounds, one of the most forcible being that it does not accord with the experience of the colour-blind. If there is any one fact more unequivocally deducible from their evidence than another, it is that the less refrangible colour they perceive corresponds to yellow, and not to green. In my own case, which I believe is a typical one, my long-wave colour is most vivid and positive, and it is an absolute certainty that its maximum splendour is excited by the buttercup, or by the pigment chrome-yellow, or by the sodium line ; whereas objects that I hear called green give me no definite impressions at all ; sometimes they assume a debased, dirty, or washed-out buttercup colour ; sometimes they look black or grey ; and sometimes they even give my opposite sensation, blue. How, therefore, it can be argued that my most brilliant buttercup sensation is excited by green objects rather than by yellow ones, is to me unintelligible.

A theory has lately been started by a Belgian *savant*, that the colour-blind defect is caused by an undue sensitiveness to green, which destroys the proper effect of other colours ; to illustrate which he says that the normal eye, by looking through a certain green solution, will become colour-blind. But he carries his theory to the further length of asserting that if a colour-blind person looks through a certain red solution, he will be restored to normal vision, a conclusion which is so improbable that we may dismiss the theory from consideration, particularly as it has found no supporters.

There is, however, another hypothesis lately offered, which has a very different aspect. It was laid before the Academy of Sciences of Vienna a few years ago by Herr Ewald Hering, Professor of Physiology at Prague. Its scope is considerably wider than has to do with our present purpose, as it embraces the whole physiological theory of the perception of light, and it would be out of the question to give a complete account of it here. It is, however, of such great importance, and has been so favourably received by some of the highest authorities, that it may be worth while to devote a future article in NATURE to its description. Meantime it may be briefly stated that the author assumes, not three fundamental colour-sensations, as in the Young-Helmholtz theory, but (excluding black and white, for which he provides separately) *four*, namely, blue, yellow, red, and green.[1]

These, however, result from only two sources of sensation, each of which is capable of a double, or reversible, mode of excitement (in a manner somewhat analogous to positive and negative in electricity, or plus and minus in algebra), producing the sensation of two colours complementary to each other. Thus, one of the sources of sen-

[1] In the description of my own case, published in the *Philosophical Transactions* for 1859, I ventured to express the view that the assumption of these four colours as fundamental, was necessary in order to explain satisfactorily the phenomena of colour-blindness.

sation corresponds to blue and yellow, the blue rays exciting it in one direction and the yellow rays in the other. The other source corresponds to red and green, and is excited in like manner. It will at once be seen with what admirable simplicity this will explain colour-blindness, avoiding the violence done to the evidence by the Young-Helmholtz doctrine. Normal-eyed persons possess both sources of sensation; colour-blind persons possess only one. The usual case is when the red-green source is absent, the patient seeing only blue and yellow; but the other defect is possible, giving blindness to blue and yellow, and vision only of red and green; and Dr. Stilling, who strongly espouses the theory, states that rare examples of this have been found. If both sources of sensation are absent, the patient sees only light and shade, and this case also is said to have been practically known.

It is a pity Dr. Jeffries has omitted to mention this theory, which, if it should be substantiated by further inquiry,[1] bids fair to be a most valuable contribution to our knowledge. In the meantime the phenomena of colour-blindness, from the important bearing they have on the nature of colour-perception generally, require much further careful investigation.

WILLIAM POLE

OUR BOOK SHELF

Elementary Lessons on Sound. By Dr. W. H. Stone, Lecturer on Physics at St. Thomas's Hospital. (London: Macmillan and Co., 1879.)

SINCE the publication, some five and twenty years ago, of Helmholtz's great work on musical acoustics, the study of the nature of sound has become popular. The ordinary phenomena of hearing must interest every one; but it is to the thoughtful student of music that the subject presents its chief attractions. We cannot imagine any intelligent musician who will not be desirous to know something of the foundation of the wonderful fabric he has to deal with, and to learn how the principles of science bear on the practice of the art.

It is well, therefore, that Messrs. Macmillan have included among their School Class Books one which gives, in a very small compass, a large amount of information as to the laws and phenomena of sound. The author has not only extracted the essence of what is contained in bulky and expensive treatises, sometimes in foreign languages, but he has also given much additional information from memoirs and transactions of scientific societies out of the reach of the ordinary public.

The application of acoustics to musical instruments is a useful addition, the subject being one which the author has made specially his own. He has also stated some of the simplest facts of the connection between acoustical phenomena and the structure of music; but this is too wide a subject, and involves far too complicated considerations to be fully dealt with in an elementary work of this kind.

We notice a few trifling errors, as, for example, on page 3, the monochord can hardly be said to be "named after" Pythagoras; and Tartini's *terzo suono* was intended by him rather as a guide to correct double-stopping than "tuning." On page 11, line 7, the expression "first partial" is probably meant to be "first overtone." On page 76 a pretty contrivance, by Mr. Francis Galton, is ascribed to Capt. Douglas Galton. These things are, however, of little consequence.

[1] It may be mentioned that one of the main points in the theory has lately received unexpected and powerful support from the brilliant discoveries of Bell and Kühne in regard to the physiology of the retina.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Local Colour-Variation in Lizards

THE interest which some notes by Messrs. Wallace and Giglioli (published in NATURE) have called forth with regard to the local variation of colour in reptiles causes me to publish these few lines.

Since the year 1874 I have been carefully studying this subject, and therefore wish to remove the generally prevailing opinion that no endeavours have yet been made to explain it. I have not thought it necessary to write this before, thinking that my works touching this subject were known to naturalists, or would have become known through the mention Mr. Carpenter makes of them. Such, however, is not the case. Neither English nor Italian zoologists have taken any notice of the newer German publications concerning the local variation of colour in lizards. They content themselves with merely mentioning many new and truly interesting instances of this variation, but leave unnoticed all attempts made to obtain an explanation of the same.

The first effort to explain this appearance was made by Mr. Eimer in 1872, at the time that the beautiful black and blue lizard was discovered on the Faraglioni rocks, near Capri. Prof. Eimer tries to explain this change of colour in the *Lacerta muralis* (which is green both on the Continent and the Island of Capri) by attributing it to an adaptation to the colour of the Faraglioni rocks. However, as those rocks are not of a bluish-black, but rather a yellowish-red colour, intermixed with a little gray, and as, moreover, the lizards there have no enemies against which they require protection, and therefore no adaptation is necessary, I considered Prof. Eimer's explanation a failure, and at the same time I tried to confirm by fresh facts my hypothesis made in 1874 ("Ueber die Entstehung der Farben bei den Eidechsen," Jena, 1874). This hypothesis, which, it is true, has till now met with little approval, is as follows:—The skin of the lizard has two layers of pigment. The black pigment, which lies lowest, gets the power, under the concentrated influence of the sun, to leave its motionless state, and is made to rise by the contraction which the nerves exercise on the cells containing it, and by forcing itself more or less upwards through the elements of the pale layer of pigment, gives us the impression of different colours. That change of colour which we are able to observe in chameleons in a short space of time, under the condition of a frequent change of light, takes place with lizards only in the course of ages, embodying itself in manifold degrees of development, and provided the animal does not change the locality, remains as a distinguishing characteristic of the form. If, however, the lizard changes its locality, if it is isolated on a rock or islet which has separated itself from the mainland, and is entirely and constantly exposed to the rays of the sun, as must naturally be the case on rocks which, like the Faraglioni or the Island of Ayre, are void of all vegetation, in that case, I say, the black layer of pigment is set in motion, and by constant successive risings to the surface at last gains a definite superposition over the yellow pigment, as has been the case with the black Faraglioni and Lilfordi lizards.

This phylogenetic development of colours can be traced (as I have already mentioned in the year 1874) by the individual development of colour in the lizard, but necessarily only under the constant strong influence of the sun on young individuals. Dr. Braun, in his work on the *Lacerta lilfordi*, informs us that the young lizard of the Island of Ayre has exactly the same colour as its typical form on the larger Balearic islands, and only turns black in the course of its growth.

Though we can only observe the turning black of these lizards in the individual growth of the animal, we can obtain a returning of the full-grown animals to their original paler colours by artificial means, that is, by preventing the rays of the sun from falling on them perpendicularly. By these means I completely discoloured numbers of the Faraglioni lizards and the brown ones from the island of Ponza. The former turned bluish-green, the latter brownish-green.

Before I pass on to an enumeration of the above-named trans-

formed lizards, I shall just mention a third endeavour which has been made to explain the black colour of the lizards inhabiting small islets.

In his interesting book, "Beiträge zur Descendenz-Theorie," Leipzig, 1876, Seidlitz has tried to introduce the belief that the black colour serves as an armour or protection to the animal against the burning rays of the sun. Thereupon I sought to prove that reptiles inhabiting the desert would need such a protection more than the others, yet they are not black.

As some might perhaps draw, from what I have said, the conclusion that, according to my hypothesis the reptiles of the desert should be also black, I must remark that the scorching rays of the sun in the desert effect so strong an elevation in the temperature of the soil, that it brings forth a relaxation in the animal, and slackens the energetic movement of the pigment, consequently the extreme heat counteracts the effect which the light produces, whilst on the islets of the Mediterranean the heat is alleviated by the sea breezes and by a certain degree of dampness. As we already know, all our European species of lizards carefully avoid the desert.

The dark-coloured lizards at present known, which inhabit small islands, are the following ones:—

1. *Lacerta muralis, var. archipelagica*, De Bedriaga: "Die Faraglioni-Eidechse." (Heidelberg, 1876; pp. 19.) *L. muralis, var.* B. Erhard: "Fauna der Cykladen," (Leipzig, 1858; pp. 80.) *L. muralis, var. C.*, Schreiber: "Herpetologia europæa." (Braunschweig, 1875; pp. 408.) *L. muralis, var. archipelagica*, v. Bedriaga: "Herpetologische Studien," im *Archiv für Naturgeschichte*, 1878.

Back and extremities black, covered with rows of green spots. Belly and tail black. Inhabits the Cyclades.

2. *Lac. muralis var. melisellensis*, Braun: *Lacerta lilfordi* and *L. muralis*; "Arbeiten aus dem zoolog. zootom. Institut in Würzburg, 1877."

Back brown, ornamented with six light longitudinal stripes. Belly dark blue, chin rather lighter. Length 130 mm. Inhabits the islet Melisello near the island of Lissa, in the Adriatic Sea.

3. *L. muralis, var. filflaensis*, De Bedriaga: "Die Faraglioni Eidechse." (Heidelberg, 1876.) Braun, *l.c.* v. Bedriaga: "Herpetologische Studien," in *Archiv f. Naturg.*, 1879. Günther: "Description of a new European Species of Zootoca," *Annals and Magazine of Natural History*, 1874.

Back black covered with small green specks, the under parts are deep blue. Length 212 mm. Inhabits Filfla, near Malta.

4. *L. muralis, var. faraglionicnsis*, De Bedriaga: "Ueber die Entstehung der Farben bei den Eidechsen." (Jena, 1874.) *L. muralis var. cœrulæa*, Eimer: "Zoologische Studien auf Capri." (Leipzig, 1874.) Braun, *l.c.*

Back black, the sides blue spotted with black; the belly a brilliant blue. Length 220 mm. Inhabits the Faraglioni Rock, near Capri.

5. *L. muralis, var. Latastei*, De Bedriaga: "Herpetologische Studien," in *Archiv f. Naturg.*, 1879, pp. 264.

Back and sides brown, or dark brown covered with black spots, sometimes with bluish green spots on the sides. Above the root of the forelegs a bluish spot. Length 205 mm. Inhabits Ponza near Gaeta.

6. *L. muralis, var. Lilfordi*, Günther: "Description of a New European Species of Zootoca," *l.c.* Braun, *l.c.*

Upper parts of a deep glossy black, lower parts of a beautiful sapphire blue. Length 175 mm. Inhabits the Island of Ayre, near Minorca.

7. *L. muralis, var. Gigliolii*, De Bedriaga: "Herpetologische Studien," 1879, *l.c.*

Forepart of the back covered with alternately green and blue stripes. The hind part of the back is dark blue. The sides are light brown with green and blue spots. The belly brick-red with (sometimes without) small blue stripes. Colouring varies. Length 175 mm. Inhabits Isla del Dragoneras near Majorca.

8. *L. muralis, var. Rasquineti*, De Bedriaga: "Herpetologische Studien," 1878, *l.c.*

Back olive brown with a black pattern. Blue eye-spots ornament the sides. Belly brick-red. The first longitudinal rows of the ventral scales are blue. Length 185 mm. Inhabits the islet La Deva near Arnao (Spain). J. VON BEDRIAGA

Heidelberg, August 28

Insect Swarms

THIS year being remarkable for "insect swarms," it is important that all possible information about them should be gained, so as to satisfactorily account for these phenomena. As to *Vanessa cardui*, which has been abundant throughout the spring and summer, it is possible that some of those specimens which occurred in the spring were the result of a migration from the Continent, but there is no doubt that the specimens which are now seen are nearly, *if not all*, bred in this country from ova deposited by the spring specimens, quite sufficient time having elapsed for the metamorphosis. With regard to *Plusia gamma*, I am of opinion that all the specimens seen, and they have been in profusion here from about August 10 till the present time, have been bred *in this country*. My reason for so believing is that the larvæ were most abundant in the spring, doing damage in gardens to a great extent. Some of these larvæ I fed up, the perfect insects emerging at the time *P. gamma* first appeared in abundance. My experience of the swarms of *P. gamma* is that they moved in no particular direction, merely passing in numbers from flower to flower, flowers being scarce this year, any apparent migration being simply a search for more flowers. Instead of putting the cause of these swarms down to "migration," endeavours should be made to discover the causes of the extraordinary periodical fecundity. It is quite probable, too, that next year, *P. gamma* and *V. cardui* will be scarce, as is frequently the case with *Colias edusa* and *hyale* after a year of abundance. J. H. A. JENNER

Lewes, September 13

Earthquakes

I HAVE observed, in several recent numbers of NATURE, various notices of earthquakes, so frequent as to suggest the idea to me (perhaps incorrect) that for several months past they have been more numerous than usual. Since my arrival in West Java I have experienced several severe shocks. On March 28, between 7 and 8 P.M., I was startled by a peculiar shivering as I sat in my chair. At first I imagined I was seized with a terrible feverless ague, but I was soon undeceived by the increased bumping and the clashing of my bottles, &c., and the vehement beseeching of *Tuhan* Allah, and the loud exclamations of the natives of, "We are here!" "We are all here!" I learned in a few days that several villages lying at the base of the peccant volcano, Gedè, had suffered; in particular the town of Ijandjoer, in which numerous houses were destroyed, many bridges broken down, the telegraph apparatus entirely thrown out of gear, and six or seven persons killed. The ground also opened and emitted volumes of smoke, while the Gedè itself burst out with extra vigour, throwing out, in addition to the usual white steamy vapour, large quantities of smoke and ashes, fortunately to no great distance. Throughout the 28th and 29th there was a succession of shocks. On June 3 I experienced a second earthquake, undulatory but not very severe; and again on the 5th, undulatory, of considerable duration, and severe enough to thoroughly shake the whole house and throw down unfixed objects. These have done no damage to life, as far as I have heard, and, beyond some houses being cracked in Batavia, little to property. Since the beginning of March there have been numerous shocks, but none so violent as those of March 28 and June 5. Immediately preceding the shock of June 5 there was a sudden and heavy fall of rain, the drops being very large. The direction of the wave was from east to west. HENRY O. FORBES

Kosala, Bantam, July

Leaping Power of Mantis[1]

I CAN state from my own observations of several different species, both in Ceylon, South Africa, and Fiji, that the power is possessed by many, chiefly in the larval stage, and that the distances they can spring from branch to branch are very considerable for the size of the insect. E. L. LAYARD

British Consulate, Noumea

OUR ASTRONOMICAL COLUMN

THE OUTER SATELLITE OF MARS.—The following positions of *Deimos*, the exterior satellite of Mars, are deduced from the data published in Prof. Asaph Hall's memoir, in which he determines the elements of the satellite-orbits:—

[1] NATURE, vol. xx. p. 595.

At Greenwich Midnight

	Pos.	Dist.		Pos.	Dist.
	°	″		°	″
Oct. 10	241·3	50·1	Oct. 21	44·0	46·8
11	28·4	23·6	22	60·8	55·7
12	55·1	61·7	23	200·6	22·4
13	98·7	15·5	24	234·0	65·7
14	229·3	56·8	25	272·4	20·6
15	245·9	42·0	26	47·1	58·0
16	39·0	36·7	27	64·9	48·6
17	57·6	60·4	28	213·4	35·0
18	161·8	12·5	29	236·6	64·7
19	231·7	63·0	30	317·7	14·4
20	254·1	31·6	31	49·7	64·2

The apparent diameter of Mars, assuming the diameter at the mean distance 9″·415, will be 17″·8 on October 10 and 19″·5 on October 31. The value adopted depends chiefly upon the double-image measures, and is smaller than that introduced in Leverrier's Tables of Mars, which was derived from observations with meridian instruments. The period of revolution of *Deimos* is 30h. 17m. 54s., and the mean distance from the centre of Mars 14,500 miles, so that the average orbital velocity is 50 miles per minute. The excentricity appearing to be very small, Prof. Hall assumes a circular orbit for prediction in 1879.

THE FIRST COMET OF 1699.—This comet was observed at Paris by Cassini and Maraldi from February 20 to March 2, and at Pekin by the Jesuit missionary, De Fontenay, from February 17 to February 26. The single orbit which figures in our catalogues was calculated by Lacaille; the following elements by Mr. Hind depending upon the observations of February 19, 24, and March 2, are very similar to Lacaille's, the only noticeable difference being an increase of rather more than 1° in the inclination:—

Perihelion passage, 1699, January 13·3998 G.M.T.

	° ′
Longitude of perihelion	212 8·8
,, ,, ascending node	321 41·5
Inclination	70 36·6
Log. perihelion distance	9·87426

Motion—retrograde.

The re-examination to a certain extent of the cometary orbits resting upon a single calculation appears by no means a futile work, as was shown by the circumstance pointed out in this column some time since, that Halley had inadvertently given the longitude of the *descending* node of the comet of 1698, in his "Synopsis of Cometary Astronomy," in place of that of the *ascending* node, and the mistake has been continued in all our catalogues.

NOTES

THE latest conflagration at Irkutsk has destroyed all the libraries of the town—the Public Library, the private one of M. Vaghine (which contained the unpublished MSS. of Gedenstrom), and that of the Siberian branch of the Russian Geographical Society, which latter contained a great variety of works about Siberia, some of them being very rare, a great number of works and MSS. on Buddhism, numerous collections of publications of foreign scientific societies (European, Asiatic, and American) who exchanged their publications with the Siberian branch, and a large assortment of works on physical sciences and natural history. The destruction of this library will be a very great loss to science altogether, if a new one be not immediately created. It would be difficult for a man of science inhabiting a great city or even the smallest town in Western Europe to understand the important services which this library—the only one in Central Asia—has rendered in the development of scientific knowledge and in giving a scientific character to the geographical exploration of Siberia. Many scientific men when staying in Irkutsk have largely made use of the library (we may name among them the well-known president of the Berlin Geographical Society, Prof. Bastian, and quote his interesting notice on Irkutsk), and the writer of these lines can testify, from his own experience, how immense were the services rendered by this library to him and to his young friends when they began their studies for scientific geographical explorations of Siberia at Irkutsk, *i.e.*, at a distance of some thousand miles from all intellectual centres. We think that all those who have the further development of scientific exploration at heart, should do their utmost to assist in creating a new and good library in that centre for the exploration of Siberia.

ON August 20 last, the centenary of the birth of Berzelius was celebrated in a fitting manner at Stockholm. All the principal newspapers commented on the event in leading articles, and reminded their readers in enthusiastic terms that through Linnæus and Berzelius Sweden obtained citizen-rights in the world of science. At Väfversunda in the province of Småland, the birth-place of Berzelius, a monument to the great chemist was unveiled on the same day, in the presence of a large concourse of country people.

THE steamship *Faraday*, which has successfully laid the new transatlantic electric cable from Scilly to Newfoundland, returns to Woolwich to take on board the shore end and the cable to be laid from Newfoundland to America. The Siemens electric works at Charlton are just now busy completing the preparation of these parts, which will be ready by the end of this month, when the *Faraday* will be moored in the Thames to receive them.

THE steamer *Dacia* left Greenwich a few days ago in order to lay the second electric cable which is to connect Marseilles and Algiers. When this communication has been established the tariff of telegraphic messages between France and Algeria will be diminished by half, being reduced to 1*d*. a word instead of 2*d*. as now. It is supposed that the augmentation of traffic with the colony will result in an increased income to the Government.

ON September 1 snow fell in the village of Neustadt (Holstein).

A TERRIBLE whirlwind is reported from the village of Hopsten, near Münster (Westphalia). It occurred on August 26, at seven P.M. The largest oaks were uprooted and broken down; many houses were partially destroyed, and *débris* of all kinds marked the path of the atmospheric disturbance, which proceeded in an easterly direction. Strange to say, the most complete calm reigned everywhere around at the time.

PHYLLOXERA has now made its deplorable entry into Italian vineyards. The destructive insect has appeared in the province of Como. The local authorities are making every effort to combat the plague.

IT was proved some time ago by M. de Heen that, for metals belonging to the same natural group, the product of the coefficient of expansion by the absolute temperature of fusion is a constant quantity. In another memoir just presented to the Belgian Academy, M. de Heen inquires how the coefficient of expansion of water varies with the nature and quantity of substances dissolved in it. He proves that there is also a remarkable relation between the coefficient of expansion of organic liquids belonging to the same homologous series and their boiling point; the product of the one by the other is a constant quantity. In connection with this, M. Spring points out that M. Pictet, guided simply by ideas introduced into science by thermodynamics, has come to the same conclusions as M. de Heen. M. Pictet shows (1) that temperature is represented by the length of calorific oscillations of the molecules of a substance; (2) that the temperatures of fusion of solids correspond to equal lengths of oscillations; and (3) that consequently, the product of the lengths of oscillation by the temperatures of

fusion must be a constant number for all solids. As the lengths of oscillation of the molecules of a body are measured by the coefficient of expansion, we see that the result is the same as that reached some time since by M. de Heen, and which is now extended to liquids.

In a series of experiments recently described to the Vienna Academy, Prof. von Waltenhofen has sought to deduce from a direct measurement of the work done in induction of an electric current in a closed circuit of given resistance, the mechanical equivalent of heat. For induction, a magneto-electric machine was used, whose electromotive force was ascertained to be proportional to the number of revolutions. A dynamometric handle of the newest construction was attached, and it was furnished with an arrangement for receiving the work-diagrams. The induced currents were measured by means of a tangent galvanometer. The results were found to be in satisfactory agreement with Joule's equivalent.

An interesting communication relating to the photography of spectra has recently been made to the Berlin Academy of Sciences by Herr H. W. Vogel. It is not very difficult to photograph the spectra of incandescent gases if the source of light is an induction spark which is produced by a current with an inserted Leyden jar. The photography of the much fainter spectra obtained by the simple induction-spark presents far more considerable difficulties, and these are the very ones which Herr Vogel has now completely mastered by the employment of so-called gelatine-dry-plates. These plates are remarkable for their extreme sensitiveness, which Herr Vogel has estimated to be at least fifteen times that of the ordinary wet plates. They keep good for years, it seems, and are already obtainable in the trade. By using them Herr Vogel succeeded in fixing the spectra of the little oxygen tubes prepared and studied by Herr Paalzow, thus rendering lines visible in the more refrangible part of the spectrum which cannot be observed by direct vision. The two gentlemen are now engaged in studying these spectra more minutely in company, and will doubtless soon publish the results of their researches.

A violent shock of earthquake, lasting forty seconds, is reported from the island of St. Thomas (West Indies). It occurred on July 30 at 11.35 A.M.

The *Temps* publishes a letter from M. Francis Laur, a mining engineer, complaining that the French Parliamentary Commission appointed for preventing the effects of fire-damp, has given no sign of life, although a credit of 50,000 francs was assigned to it, and more than fifty inventors have sent in instruments or methods for examination.

M. Ferry, Minister of Public Instruction, has published an official circular for the better organisation of the bursaries granted after examination to students taking their degrees in the several French universities. These bursaries are of quite recent foundation and present a strong similarity to the sizarships or scholarships in the English universities.

Amongst European countries there are two where science has been dreadfully neglected up to the present time. For one of these two, viz., Turkey, we are afraid there is not much hope of reformation, at least in its present condition. It is satisfactory, however, that the other one, viz., Spain, seems at last to be awaking from its lethargy with regard to science. Some time ago we had occasion to refer to a commendable *Cronica cientifica*, published annually in two volumes, by Dr. Emilio Huelin, of Madrid. Another publication which appears monthly, the *Revista contemporanea*, of which Dr. Francisco de Asis Pacheco is the editor, has just come under our notice. The last number of this serial contains an excellent article on the sciences in 1879, by Ricardo Becerro y Bengoa, giving a most elaborate account of the work done recently in all branches of science. The publishers are Señores Perojo Hermanos, of Madrid, who also publish *La Naturaleza*, an illustrated science review, in two volumes annually.

The project of building a canal from Amsterdam to the Rhine (in continuation of the new canal between that city and the German Ocean) has lately been again brought before the Dutch Government. Our readers are aware that the project is not new, and it is easy to see the great advantages its execution would bring to the commerce of Holland generally and of Amsterdam in particular.

At a recent meeting of the United States Anthropological Society, Mr. F. H. Cushing, who has made an original and experimental study of aboriginal processes in the manufacture of pottery, stone axes, and flint arrow-heads, using only the tools which were within the reach of the aboriginal manufacturers, gave an interesting description of the manner in which flint implements, especially arrow- and spear-heads, were made by the prehistoric inhabitants of this country and Europe, previous to the discovery or introduction of iron. It is the popular impression that flint arrow-heads were all chipped into shape by striking off fragments with a rude stone hammer, and this was the method first tried by Mr. Cushing. He found, however, that it was impossible to imitate in this way any of the finer and more delicate specimens of Indian arrows, and that three out of four even of the coarser forms were broken in the process of manufacture. It was evident, therefore, that the Indians had other and more delicate processes. After many unsuccessful experiments, he accidentally discovered that small fragments could be broken off from a piece of flint with much greater certainty and precision, by pressure with a pointed rod of bone or horn, than by blows with a hammer-stone. The sharp edge of the flint would cut slightly into the bone, and when the latter was twisted suddenly upward a flake would fly off from the point where the pressure was applied in a direction which could be foreseen and controlled. To this process Mr. Cushing gives the name of flaking, to distinguish it from chipping produced by percussion. And its discovery, he considers, removes most of the difficulties which previous experimenters had met with in trying to work flint without the use of iron. Spear- and arrow-heads could in this way be flaked even into the most delicate and apparently fragile shapes with a certainty attainable in no other way, and with a greatly-lessened probability of breakage. Mr. Cushing then described, with the aid of blackboard illustrations, all the steps in the manufacture of an arrow, beginning with the striking off of a suitable flake from the mass of material selected, trimming it roughly with a pebble into a leaf-shape with a bevelled edge, scaling off surface flakes by repeated blows with a hammer-stone upon this edge at right angles to its plane, and finally finishing, pointing, and notching the arrow-head with the bone flaking-instrument previously referred to.

The Russian Foreign Ministry has just published a very good Russian and Chinese dictionary, by the first translator of the Russian mission at Pekin, M. P. S. Popoff. The work is printed by a new kind of autography devised by M. Alisoff.

M. Ferry has published an order for the appointment of librarians in the establishments of the University. No one is to be appointed except after two years' trial and passing successfully a professional examination. This is to consist of a French dissertation on a given subject of bibliography, and the classification of fifteen works treating of different matters, and belonging to several periods of the history of the art of printing.

The Musée Scolaire, which had been removed by the Minister of Public Instruction to one of the halls of the Palais Bourbon, is to resume its former situation. The hall in which it had been located is wanted by the questors for the installation of the

Chamber of Deputies which, as is known, is to be transferred to Paris in November next, there to hold its sessions, so long as the Parisians do not oppose it by a revolution.

AT the Stuttgart meeting of the International Geodetic Association in 1878, M. Faye suggested a method of avoiding the flexure of a pendulum-support, viz., that two similar pendulums should be oscillated on the same support with equal amplitudes and opposite phases. The idea was thrown out on the spur of the moment, and was not received with very warm approval. By a mathematical discussion of the method in a paper to the U.S. National Academy (*Silli. Journ.*, August), Mr. Peirce endeavours to prove that the suggestion is as sound as it is brilliant, and offers some peculiar advantages over the existing method of swinging pendulums.

AT the International Alpine Congress at Geneva Prof. A. Favre pointed out the necessity of making measurements of glaciers. The retrocession of glaciers has been general during the last twenty-five years. Prof. Favre is of opinion that this retrocession period will come to an end after some time, and will be succeeded by a period of advance. The German and Austrian Alpine Club, at its last general meeting at Saalfelden, resolved to make the measurements in question on all the glaciers of the Austrian Alps.

THE third volume of Dr. Karl Russ's work on foreign domestic birds, containing the natural history and cultivation of parrots, has just been published by C. Rümpler, of Hanover.

A NEW oil plant (*Lallemantia iberica*) has been acclimatised on the fields of the Agronomical School at Cherson (South Russia). It belongs to the *Labiatæ* family, and is very similar to *Dracocephalum*. The herb attains a height of 1½ to 2½ feet and bears some 2,500 seed-grains, which give a most pure oil, applicable even for culinary purposes. The seeds of this originally Persian plant were first sent to Cherson by Prof. Haberlandt, of Vienna.

WE learn that M. Europeus still continues his most interesting researches into the prehistoric Finnish population of North-Western Russia. During last summer he explored the *koorganes* (mounds) of the province of Olonets, and on the banks of the Oyak river he discovered many bronze implements similar to those brought in by Ujfalvi from the banks of the Irtysh in Siberia. The remains of the Korels in the district of Olonets throw a new light on the geographical distribution of this people. M. Europeus has arrived at the conclusion that during the first centuries of the Christian era the whole of North-Eastern Europe and the north of the Scandinavian peninsula were peopled by tribes of Finnish-Hungarian and Finnish-Ugrian origin, who formed an extensive and strong state. Only the shores of Lake Onega had a purely Finnish population. All skulls in the *koorganes* of the region formerly occupied by Finns, are of the brachycephalic form.

COUNT T. SALVADORI'S great work on Papuan ornithology, "Ornitologia della Papuasia e delle Moluche," is in a forward state, and it is hoped that the first part (containing the Accipitres, Psittaci, and Picariæ) will be ready about the end of the year. The second part will be devoted to the Passeres, and the third to the remaining orders. The total number of species contained in the work will be about 900, the area embraced being the whole of the Austro-Malayan sub-region, with the exception of Celebes and the Timor group of islands.

A RAILWAY is now being built between Tiflis and Baku, and is expected to be completed in about four years.

WE have received the fourth volume of the *Bulletin* of the Société Ouralienne, *i.e.*, the Natural History Society of Ekaternburg, Russia. The volume contains some interesting data on the flora of the Ural Mountains, by M. G. O. Clerc; also some notes on rain-gauges and on the quantity of rain and snow which falls at Dolmatoff (average computed from observations extending over fourteen years), by the same. Another valuable contribution is by M. N. P. Boulytcheff, and treats of the flora and the fauna of the Irbit District. All these papers are given in the Russian original and in a French translation. An original German paper is by Dr. J. Hann, on the daily course of magnetic declination in Russia, but only the Russian translation is printed.

THE Congress of German Horticulturists which took place at Cassel this year will meet at Bremen next year.

AT South Arcot (Presidency of Madras) experiments have been recently made with the fibres of aloes, which grow there in abundance, with a view of preparing paper from this material. A product was obtained which considerably surpassed the ordinary Indian paper in quality, and it is now intended to make the experiments on a larger scale in this country.

THE St. Gothard tunnel, which will measure 14,920 metres when completed, has now reached a length of 13,229 metres. It is hoped that by the beginning of December next the gigantic work will be finished.

THE additions to the Zoological Society's Gardens during the past week include a Guinea Baboon (*Cynocephalus sphinx*) from West Africa, presented by Mr. F. Naylor; a White-fronted Capuchin (*Cebus albifrons*) from South America, presented by Major H. L. Gleig; a Black-faced Spider Monkey (*Ateles ater*), two Black Tortoises (*Testudo carbonaria*) from South America, two Martinican Doves (*Zenaida martinicana*) from the West Indies, presented by Capt. Henry King; a Plantain Squirrel (*Sciurus plantani*) from Java, presented by Miss Lizzie Casey; an Indian Jackal (*Canis aureus*) from India, presented by Mr. Thos. Thursfield, M.R.C.V.S.; a Demeraran Cock of the Rock (*Rupicola crocea*) from Demerara, presented by Mr. R. S. Fraser; a King Parrakeet (*Aprosmictus scapulatus*) from New South Wales, presented by Mr. Geo. Wood; a Red and Blue Macaw (*Ara macao*), a Red and Yellow Macaw (*Ara chloroptera*) from South America, deposited; an African Brush-tailed Porcupine (*Atherura africana*) from West Africa, a Vulpine Squirrel (*Sciurus vulpina*, var. *capistrata*) from North America, purchased.

THE BRITISH ASSOCIATION

REPORTS

Report of the Committee for exploring Caves in Borneo. Drawn up by Dr. J. Evans, F.R.S.—The Committee report that with the grant of 50*l.* from the Association, a similar grant from the Royal Society, and a farther sum of about 200*l.* from private sources, they have been able to prosecute an examination of various caves in Borneo, under the superintendence of Mr. A. S. Everett, who has devoted himself to the task for a period of nearly nine months.

The final report upon his work has not yet been received, but it appears from his letters and from the specimens which have been transmitted to this country, that nothing of special interest either from an anthropological or a geological point of view has resulted from his explorations. The animal remains discovered have all been of recent species; the human bones are probably of no great antiquity, and none of the few objects of human manufacture which have been found can be regarded as of palæolithic age.

Pending the arrival of Mr. Everett's final report it appears needless to enter into details; but it may be mentioned that upwards of twenty caves appear to have been explored, in a more or less complete manner, and the principal objects found, after examination by some of the members of the Committee, have been forwarded to the British Museum. Although the examination of these caves has not, as was hoped, thrown any light upon the early history of man in that part of the world, it is still satisfactory that the examination should have been made

and the character of the cave-deposits ascertained by so competent an observer as Mr. Everett. The evidence obtained, though negative, is not without value, and those who are specially interested in cave-explorations, and who have so liberally assisted in the present instance, cannot be reproached with not having availed themselves of the opportunity afforded by Mr. Everett's presence, of obtaining farther information as to the contents of the Borneo Caves.

It may be added that though for the most part the objects secured were unimportant, there were among the cave-deposits a number of shells of land and freshwater mollusca, which have been examined by Col. Godwin-Austen, and have proved to belong to at least 25 genera and 40 species, some of which are apparently new. Mr. Everett has been requested to devote some attention to collecting a larger series of these shells, but owing to the difficulties of postal communication it is possible that the request may arrive too late.

The Committee propose to communicate Mr. Everett's final report, together with any observations which seem called for on the specimens which are still to arrive, to the Royal Society.

Underground Waters.—The fifth report was presented of the Committee appointed in 1874 to inquire into the circulation of underground waters, and the extent to which they may be made available for the water supply of towns and districts. The Committee state that, as the objects of the inquiry become more widely known, there is increasing inclination shown by engineers and contractors to impart information, which accrues from day to day, and that they consider it desirable to continue their labours until it becomes the duty of some Government department to undertake the charge. They desire to extend their inquiry beyond the Permian, Triassic, and Jurassic rocks to all permeable formations yielding supplies of potable waters. A large amount of valuable information has been collected in the Midlands and in other districts, of works in progress which will be reported on next year. The attention of the Reporter of the Committee (Mr. De Rance) has been specially directed to ascertaining the areas of pervious rocks, in each of the river basins of England and Wales, and of the areas of impermeable rocks overlying permeable formations, and forming "supra-pervious" areas, together occupying an area of more than 25,000 square miles, and capable of yielding an amount of water far in excess of the quantity required for manufacturing and potable purposes. The impermeable nature of the Severn river-basin is alluded to, and the consequent danger of abstracting a large volume of its waters for Liverpool water supply commented on.

Report of the Anthropometric Committee.—This Committee had been appointed for the purpose of continuing the collection of observations on the systematic examination of heights, weights, &c., of human beings in the British Empire and the publication of photographs of typical races of the empire. Considerable progress had been made during the past year, and returns, giving the birth-place, origin and sex, age, height and weight, colour of hair and eyes, girth of chest, strength of arm and eyesight, of pupils at Westminster and other schools, London policemen and letter sorters, workmen, rifle volunteers, soldiers and criminals, had been obtained. By this means the Committee were put in possession of nearly 12,000 original observations on the main question of weight and height in relation to age, in addition to 50,000 already collected. The Committee submitted a series of tables made up from the information contained in the returns. From these it was shown that the London letter sorters were the lowest in height, the average heights between the ages of 20 and 35 being 64 to 67·1 inches. The letter sorters were also at the bottom of the weight table, their average weights in lbs. being 122·5 to 139·9. The metropolitan police were at the head of both lists; height 69·2 to 71·5 in., and weight 162·5 to 182·7 lbs. Other tables were given, showing that the average height and weight varies with the social position and occupation of the people, and that to obtain the typical proportions of the British race it would be necessary to measure a proportionate number of individuals of each class. Taking the census of 1871, they would find that a model community would consist of 14·82 per cent. of the non-labouring class, 47·46 per cent. of the labouring class, and 37·72 per cent. of the artisan and operative classes. The nearest approach to such a representative population in a limited space would be found in some of the larger county towns, such as York, Derby, or Exeter. The tables demonstrated that the full stature is attained in the professional class at 21 years, and in the artisan class between 25 and 30 years. American statistics showed that a slight increase in height takes place up to the 35th year. The growth in weight does not cease with that of the stature, but continues slowly in both classes up to about the 30th year. The report concluded by referring to similar investigations which are being made in other countries, and the coincidence of the several inquiries led to the hope that information of great value might in due course be elicited.

SECTION A—Mathematical and Physical

On Secular Changes in the Specific Inductive Capacity of Glass, by J. E. H. Gordon, B.A.—At Christmas, 1877, I made some determinations of the specific inductive capacity of optical glass by a method which has already been fully described both before this section and elsewhere.[1]

At the end of July, 1879, I commenced a repetition of the experiments, using the same slabs of glass, and was surprised to find a large increase in the specific inductive capacity in every case. In some cases the increase was as much as 20 per cent. The following is a table of the results:—

Specific Inductive Capacity of Optical Glass

	Christmas, 1877	July and August, 1879
Double extra dense flint	3·164	3·838
Extra dense flint	3·053	3·621
Light flint	3·013	3·443
Hard crown	3·108	3·310

The arrangement of the apparatus, including the coil and rapid break, was precisely the same as in my earlier experiments. The electromotive force was as nearly as possible the same, and experiment has shown that moderate variations in it do not affect the results.

The differences observed might have been caused by any one of three things:—

1. By error in the 1879 experiments.
2. By error in the 1877 experiments.
3. By a change in the specific inductive capacity of the glass between Christmas 1877 and July 1879.

[The author, after showing reason for the rejection of (1) and (2) is led to the conclusion that in the course of a year and a half an actual change has taken place in the glasses, which is shown by a considerable real increase in their specific inductive capacities.] To complete our knowledge of this new phenomenon we require a series of monthly observations, extended over perhaps a period of several years. I shall hope to be able to give the results of another year's experiments at the next meeting of the Association.

These experiments have some importance as regards Prof. Clerk-Maxwell's electro-magnetic theory of light. In a recent lecture[2] I ventured to suggest "that it is quite possible that the relation between electric induction and light exists—namely, that they are disturbances of the same ether, but that there is some unknown disturbing cause affecting the electric induction."

Possibly a clue to the nature of this disturbing cause may be found in the fact, that the specific inductive capacities are affected by some of the changes which chemists tell us are constantly going on in glasses, but that these changes do not affect the refractive indices.

SECTION B—Chemical Science

Mr. W. Chandler Roberts, F.R.S., Chemist of the Mint, read a paper *On some Experiments with the Induction Balance.*—He stated that the instrument, which we owe to Prof. Hughes, the discoverer of the microphone, appeared to be one of no ordinary importance, and although the experiments about to be described were far from complete, they possessed sufficient interest to warrant their being submitted to the Section. He then described and exhibited Prof. Hughes's instrument, showing the extreme delicacy by which changes in the induced current were indicated by the microphone and telephone.

The relative values of different metals, as indicated by the induction balance, do not accord with the values usually accepted as representing the relative conductivities of the respective metals, and this being the case, Mr. Roberts had ascertained what rela-

[1] *Report* Brit. Assoc., 1878; *Proc.* Roy. Soc., 191. 1878; *Phil. Trans.*, 1879; "Four Lectures on Electric Induction," delivered at the Royal Institution (Sampson Low and Co., 1879.)
[2] Royal Institution, February 6, 1879.

tion the indications given by alloys, when under the influence of the induced current, bear to their electric conductivities.

The experiments on a comprehensive series of alloys proved that, in the case of alloys of certain metals, the induced-current curves closely resembled those representing electric conductivity, but that in certain other cases the induced current revealed differences that had hitherto escaped observation. As an example, Mr. Roberts alluded to the curve of the copper-tin alloys, in which there is a sudden break between the points representing two alloys, which only vary by a single equivalent, or by 6·4 per cent. of copper. These two alloys are widely different in colour, fracture, density, and structure, and the induction-balance at once afforded evidence of a marked difference not shown in Matthiessen's curve of electric conductivity.

It is known that certain metals, when alloyed, undergo a molecular change, and that an allotropic condition may in some cases be induced by alloying a metal with a small quantity of another, facts which well deserve minute examination as bearing on the non-elementary character of certain metals, which is now receiving so much attention.

Mr. Roberts then referred to the question of applying the induction-balance to the assay of metals. In the case of gold-silver alloys the instrument will show the presence of less than two grains of gold in the pound of silver. On the other hand, the silver-copper alloys used for coinage are situated at the flat portion of the curve, so that it is impossible to detect even considerable differences in their composition, and these alloys which are very peculiar to their nature, appear to be greatly affected by annealing. More hopeful results were obtained with the gold-copper alloys, and Mr. Roberts demonstrated a difference of 1 per cent. in the standard of two gold disks, which, though far short of the existing method of assay in delicacy, appeared to afford grounds for the belief that very accurate results will ultimately be obtained.

Notes on Petroleum Spirit or Benzoline, by A. H. Allen.—The application of the commercial names "benzoline" and "benzine" to the more volatile portion of petroleum has led to great confusion between petroleum spirit and coal-tar naphtha, the most characteristic constituent of which is the hydrocarbon *benzene* or *benzol*. In this paper the author mentions several tests for distinguishing between the two bodies, the most important of which are the following:—

Petroleum Spirit, "Benzoline or Benzine," warmed with four measures of nitric acid of 1·45 sp. gravity the acid is coloured brown, but the spirit is little acted on, and forms an upper layer.

Coal-Tar Naphtha or "Benzol" is completely miscible with four measures of nitric acid of 1·45 sp. gravity, with great rise of temperature and production of dark brown colour.

These tests are capable of yielding quantitative results if the treatment with nitric acid be conducted in a small flask and an inverted condenser attached, to prevent loss of vapours. When action has nearly ceased, if the liquid be poured into a narrow graduated tube, the measure of the upper layer indicates with approximate accuracy the amount of petroleum spirit present. If the proportion of benzene is considerable, the nitrobenzene produced may not remain completely dissolved in the nitric acid, in which case it rises and forms a layer of a dark brown colour below the stratum of petroleum spirit. Nitrobenzene and petroleum spirit are readily miscible in the absence of nitric acid, but agitation with strong nitric acid dissolves out the nitrobenzene, a portion of which may rise and form an intermediate layer as above described.

By fractional distillation, the author found that the proportion of *heptane*, C_7H_{16}, present in commercial benzoline probably equalled, or even exceeded, that of all the other constituents.

On some Curious Concretion Balls derived from a Colliery Mineral Water, by Thomas Andrews, F.C.S.—The water on which these observations were made was collected from the "sump" of the Wortley Silkstone Colliery, a small pit situated near the "Bassett" or "outcrop" of the great Silkstone seam of coal, the samples being obtained during typical *dry* and *rainy* seasons. The water had percolated from the surface a distance of thirty-five yards, through strata, as indicated on the accompanying table.

The bottom layer in which the water lodged was the Silkstone seam of coal, here some five feet in thickness.

One noticeable feature of this water is that it always gives an acid reaction with blue litmus paper.

Several analyses of this water made at various times indicate that the chief mineral constituents of the water are, iron—calcium, magnesium, in the form of sulphates.

This water when heated quickly throws down a copious ochreous deposit. The deposit found in the engine boilers, after having used the water in them for steam purposes was of the composition given below.

The boiler residue from which this sample was taken consisted of an incrustation about *one inch* thick, which had adhered to the bottom of the boiler.

The incrustation was of a light reddish yellow colour in the bulk, it was very hard and tough, and not easily broken in pieces.

The iron work in connection with this colliery engine and boilers, in any way exposed to the action of either the acid water itself or *the steam generated from it*, becomes corroded and partially dissolved. The most effectual remedy against this corrosive action and deposit is that described in my letter to the *Chemical News*, June 15, 1877.

Some curious balls of mineral matter are occasionally found in the feed tank of the colliery boilers, which are supplied with this water. The water is pumped up from the engine pond into a cylindrical feed tank, and is there heated by the exhaust steam from the engine playing on its surface (not blowing through it). The water in this feed tank has an average temperature of 164° F.

It sometimes happens that during the short space of even two or three weeks, great numbers of these balls are formed, varying in size from about three and a half inches in diameter to five-eighths of an inch diameter, and in weight from about one and a half pound to a quarter of an ounce.

The author has many of these in his possession. They are perfectly hard and compact when taken from the tank, and are, no doubt, formed from the deposit thrown down when the mineral water is heated.

The action of steam playing on the surface of the water probably causes circular eddies, and when a nucleus has thus once been formed, it is easy to conceive of the gradual formation and consolidation of these balls.

The author suggests that the conditions of formation of natural nodules of iron ore, pyrolusite, &c., may be similar to those observed by him in the foregoing cases.

On the Detection of Milk Adulteration, by William H. Watson, F.C.S., &c.—From analyses of milk from various dairies, and by a comparison of the results obtained with circumstances existing as to the character and quantity of the food; nature of different cows; conditions and health of them at particular periods; and changes of the seasons of the year, the author concludes that cows' milk is subject to considerable variations in composition. He has found, in many instances, milk from well-fed healthy cows to contain as little as 10·5 per cent. of total solids, and from 8·5 to 9 per cent. of solids not fat. The results of other experimenters are compared, and it is then suggested that the present limits adopted by public analysts for genuine milk should be reconsidered.

SECTION C—Geology

On the Volcanic Products of the Deep Sea of the Central Pacific, with Reference to the "Challenger" Expedition, by the Abbé A. Renard and J. Murray.—The mineralogical and petrological researches on the sea-bottom of the Pacific area, extending from the Sandwich Islands to 30° S. lat., and having the Low Archipelago on its approximate centre, show that volcanic matter plays an important part there. It is present in the form of lapilli and of ashes spread in great abundance in the "red clay." These lapilli nearly all belong to the basaltic type, passing from the felspathic basalts to allied rocks, in which the vitreous base assumes greater and greater development, until it almost completely displaces the crystalline constituents of basalt. The fragments then become mere glassy rocks of the basic series, in which generally are still found crystals of peridote and numberless crystallites, which are sometimes grouped in opaque granules, or arranged regularly around the microliths of peridote. The forms of these volcanic fragments, which are often coated with manganese, their association with volcanic ash, and their lithological constitution, show them not to be derived from submarine flows of lava. They must rather be regarded as incoherent products, or lapilli, the accumulations of which in the Pacific form a series of submarine tuffs. One of the most remarkable facts elicited by the soundings in the Pacific is the large share

taken in these sedimentary deposits by palagonites, quite identical in lithological characters with those of Sicily, Iceland, and the Galapagos Islands. One may, in fact, call them glasses of the basic series, playing the most important part among the sediments of the Pacific, and consisting either of sideromelane or decomposed into a red resinoid substance. The small lapilli of two or three inches in diameter are cemented by zeolites, the crystalline forms of which are those of christianite. It is enough to indicate the presence of the easily alterable basic glasses, in order to show the source of the clayey matter with which they are associated, since it is known that wherever rocks of this type occur, there also decomposition into clay is observable.

Amongst the minerals present in the volcanic ash are rhombic tabular crystals of plagioclase, augite, magnetite, with a little sanidine or hornblende. It is also remarkable to notice that in these deep-sea deposits quartz grains are practically absent, in striking contrast to the coast-deposits. It is not, however, this fact which is most worthy of note, since it is not so unexpected as the formations of *zeolites* in the free state. The latter phenomenon takes place in the zone in question where minute fibrous radiated spherules are formed in the mud, possessing the crystallographic characters of christianite. Besides these zeolitic globules, there are other crystals of the same kind in the form of very minute prisms, occurring in such prodigious numbers that they make up about a third of the red clay. Crystallographically these microliths must be referred to those forming the zeolitic spherules. The authors regard them as belonging to one species. The formation of these zeolites and of the red clay in which they are developed, is easily understood if we bear in mind the lithological nature of the above-described basic tuffs and of their products of decomposition.

The Geological Age of the Rocks of West Cornwall, by J. H. Collins, F.G.S.—Mr. Collins endeavours to show that a large area of West Cornwall, hitherto mapped as Devonian, really consists of upper Silurian rocks; lower Silurian rocks underlie them, whilst a still older series occurs at several points on the coast—possibly the mica schists of the Lizard belong to this oldest series.

Geological Facts observed in Natal and the Border Countries, by Rev. G. Blencowe.—Mr. Blencowe describes the country near the border of Zululand. The rocks are sandstone, capped by trap, which often stands out in isolated hills rising 2,000 feet above the plain. Evidences of ancient volcanic action are noticed.

On "Culm" and "Kulm," by Prof. G. A. Lebour, M.A., F.G.S.—He suggests that the English word "culm" be retained as a local term for the culm measures of Devon and Somerset. Under the Germanised form of the name ("kulm") are now grouped a vast mass of carboniferous slaty beds which strike across Europe from Eastern Silesia to the westernmost point of Portugal; these beds represent, not the coal measures of England, but the carboniferous limestone and underlying beds.

On some Remarkable Pebbles in the Boulder Clay of Cheshire and Lancashire, by Dr. C. Ricketts.—The pebbles give evidence of having formed parts of moraines on land. As they occur at different horizons it is inferred that there must frequently have been an advance and retreat of glaciers, moraines being formed during the retreat of the glacier, which were carried forward into the sea when the glacier advanced.

Notice of the Occurrence of a Fish Allied to the Coccosteus in a Bed of Devonian Limestone near Chudleigh, by J. E. Lee, F.G.S. —This occurs (in the upper or middle Devonian) with clymenia, goniatites, and crinoidal remains, and therefore cannot here be a freshwater fish.

Evidence of the Existence of Palæolithic Man during the Glacial Period in East Anglia, by Sydney B. J. Skertchly, F.G.S., H.M. Geological Survey.—The object of this paper is chiefly to record the sections in which the author has discovered palæolithic implements beneath the chalky boulder clay in East Anglia.

The beds which yield the implements are a series of loams, clays, and sands, to which the author has given the name of Brandon Beds. They occur at the top of the middle glacial series of Messrs. S. V. Wood, jun., and F. W. Harmer, and underlie the chalky boulder clay or upper glacial of the above-named authors.

On Carboniferous Polyzoa and Palæocoryne, by G. R. Vine.—In this paper the author drew attention to the inadequate study that had been given to the carboniferous Polyzoa. During the last few years vast masses of shales, containing Polyzoa and other remains have been brought to light, but none that he was acquainted with excelled in richness the Hairmyres *débris*. Here the specimens were well preserved and the characters of the several species were almost perfect.

The author considered that it was too early yet to draw up a classification that would be satisfactory to all naturalists. Attempts had been made to do this, but many details had to be furnished that could only be furnished after close study. Besides the *Fenestella*, other genera were alluded to in the paper, such as *Cenopora*, *Rhabdomeson*, *Hyphasmapora*, *Glauconome*, and *Diastopora*; but these are being studied analytically, and further details of their structure will be brought forward in a future report.

Palæocoryne was next alluded to, and the author said that he had identified all the species and forms of Palæocoryne that had been figured by Dr. Duncan in his various papers; but the conclusion the author had arrived at was—that these so-called organisms were neither hydroid, as was supposed by Dr. Duncan, nor foraminiferal, as was suggested by Dr. Allman. All the forms were referable to species of *Fenestella* and *Polypora*. Although this opinion was given with some confidence the author was not prepared to say at present that the whole of Dr. Duncan's views were illusive. There can be no doubt but that the forms *P. scotica* were really infertile processes; but *P. radiata* had presented so many peculiar details to the author, that until he had satisfied himself as to the nature and purpose of this structure in the polyzoary of the Polyzoa, he was not prepared to substantiate that Dr. Duncan had given an erroneous judgment, although *P. radiata* may turn out to be after all a portion of *Fenestella* and not a parasite.

On the Replacement of Siliceous Skeletons by Carbonate of Lime, by W. J. Sollas, M.A., F.G.S., &c.—The author gave an account of certain calcareous fossil remains which exhibit, both in gross and minute structure, a close resemblance to certain existing siliceous sponges, and which differ widely from any known form of calcareous sponge. The natural inference appeared to be that the calcareous fossils were once siliceous sponges, the siliceous parts of which had undergone replacement by carbonate of lime. The alternative view that the fossils were originally calcareous, and that they represent an extinct group of Calcispongia, was discussed and shown to present far greater difficulties to the zoologist than the inferred mineral replacement offered to the chemist. Siliceous sponge spicules were stated to be remarkably soluble, yielding readily to the attacks of minute boring algæ, and undergoing solution in sea-water soon after the death of the sponge which possessed them.

The radiolaria of the carboniferous limestone were likewise regarded as having once possessed a siliceous composition, which they had since exchanged for a calcareous one.

On the Foundations of the Town Hall, Paisley, by M. Blair.—Dolerite underlies the boulder-clay there, and is probably the source of boulders of a similar rock which occur in the drift, and which have hitherto been considered as strangers to the neighbourhood.

On "Ostrakocanthus dilatatus" (gen. et sp. nov.), a Fossil Fish from the Coal-Measures South-east of Halifax, in Yorkshire, by J. W. Davis, F.G.S.—This is an ichthyodorulite nearly $1\frac{1}{2}$ inches long, and $\frac{3}{4}$ inch broad at the base. From the base the diameter diminishes rapidly, and at half an inch from the apex it is only ·15 of an inch. It remains of this size to the apex, and ends in a blunt point. The upper part is smooth, with hard ganoid covering. The lower part is longitudinally furrowed, increasing by bifurcation towards the basal end. At first sight it somewhat resembles the *Byssacanthus* of Agassiz, and also the spine of *Ostracion cornutus*, but the similarity disappears on closer examination. From the spine and its mode of attachment it is probably a representative of the Teleosteans during the coal period.

SECTION D—BIOLOGY

Department of Zoology and Botany

On the Capreolus or Spermatophore of some of the Indian Species of the Helicidæ, by Lt.-Col. H. H. Godwin-Austen, F.Z.S., &c.—The author points out the importance of the examination of the animal in many genera of the Helicidæ, and thus to obtain better characters for specific distinction than are often presented by the shell alone. The organ first discovered and described by Lister in 1694 is treated of, and the views of later naturalists al-

luded to. Many different forms of the spermatophore found in Helices from Eastern Asia, are shown and the position of the organ in the generative system of *Helicaria magnifica* from Burmah is described.

On Budding in the Syllidean Annelids, chiefly with Reference to a Branched Form from the "Challenger," by Dr. W. C. McIntosh, F.R.S.—Propagation by budding is a prevalent feature amongst the Cœlenterata, the organisms assuming in many cases a dendritic appearance, so that the name of sea-trees given to them by our fishermen is by no means inappropriate to their external contour. A similar condition is seen in many of the Polyzoa, and in the creeping stolons of *Clavelina* and *Perophora*. In the sub-kingdom Vermes, again, naturalists have been long familiar with a mode of propagation by division or fissiparous development. Thus O. F. Müller describes two kinds of budding in the fresh-water *Nais proboscidea*, and gives an account of the same process in *Nereis prolifera*. Amongst others, De Quatrefages and Frey and Leuckart in the same species; Milne-Edwards in *Myriandra*; Sars in *Filigrana*; O. Schmidt in *Nais microstoma* and *Filigrana*; Max Schultze, R. Leuckart, and Traube in the former species; Alex. Agassiz in *Autotytus cornutus*; Schmarda in *Catenula*; and Lankester in *Chætogasta*, show how widely this mode of development has been recognised. The feature that mainly concerns us at present in regard to these descriptions is the fact that a new animal is produced in a line with the old by various modifications of budding. In no instance is there any approach to a branched condition by lateral offshoots from either parent stock or bud. As an example of one of the best known marine forms, the account of *Autolytus cornutus* by Alexander Agassiz may be cited. This species exhibits a kind of alternation of generation, the parent stock (which is a sexual) giving rise posteriorly to male and female buds which differ much in appearance from each other. The latter produce ova, which by and by develop in the peculiar body-sac into a swarm of parent stocks with which the cycle commenced.

The discovery of a species (*Syllis ramosa*) of the same family (*Syllidæ*), which forms an intricate series of branches by lateral budding of the parent stock, by Sir Wyville Thomson in a hexactinellid sponge from Zebu, is one of the remarkable results of the *Challenger* expedition.

A detailed account of the animal then followed, and the remarkable absence of all trace of a head prominently noticed.

Embryology of Gymnadenia conopsea, by F. Marshall Ward. —The researches of the last two years, especially of Strasburger[1] and Warming,[2] and also of Vesque,[3] have yielded results sufficiently at variance with the older ones to warrant a serious reconsideration of the whole question of homologies. The main points may be put somewhat as follows:—

The embryo-sac is not the result of simple enlargement of one cell; a cell of an axial series of the ovule enlarges and cuts off two or more cells from its apex—the remainder becomes the embryo-sac,[4] and causes dissolution of the others as it enlarges, their remains persisting as refractive caps for some time. The protoplasmic contents of the embryo-sac separates into two chief masses, which pass to the opposite ends of the enlarging sac, a large vacuole forming between. Each mass then suffers division into four by planes cutting one another at right angles. In this way eight nucleated masses of protoplasm without cell-walls arise, three of which remain at each end of the embryo-sac, while one from each end wanders towards the centre of the sac and there fuses with its neighbour to form the nucleus of the sac.

Of the three anterior nucleated masses, two become elongated, fit into the top of the embryo-sac as the "Gehülfinnen," or "synergidæ," of Strasburger, and are probably what Schacht described as the "filiform apparatus"; their function is somewhat obscure, but appears to be related to the act of fertilisation between the end of the pollen-tube and the third nucleated mass, which has rounded off as a large bright egg-cell or ovum, and is suspended from the base and sides of the "Gehülfinnen."

The three posterior masses may not become completely isolated, or they may remain passive, or some may disappear, or they may multiply by division. Where endosperm is formed they appear to enter into its formation.

The author finds in Gymnadenia,[5] Butomus, Alisma, Anthericum, and Ranunculus ovules, confirmation of these views.

[1] "Ueber Befruchtung u. Zelltheilung," and "Die Angiospermen u. Gymnospernem."
[2] *Ann. des Sc. Nat. Bot.*, 1878. [3] *Ann. des Sc. Nat. Bot.*, 1878.
[4] Vesque, however, thought a fusion of at least two superposed cells produced the embryo-sac.
[5] Strasburger has partly worked this, so far as the first divisions of the embryo-sac mother-cell are concerned. He also gives figures of Anthericum. Vesque's account of Butomus is not supported by the author's drawings.

With reference to Warming,[1] and Vesque's[2] view that the origin of the embryo-sac is comparable to that of the mother-cell of pollen, and that the eight nucleated masses arranged in fours are therefore homologues of pollen grains (*i.e.*, spores), the following facts are of importance, as failing to support the theory:—1. The diffluent cell walls which form between the cells cut off by the embryo-sac mother-cell, are in no way important on account of their resemblance to the diffluent walls in pollen formation; they also resemble the diffluent walls formed in the suspensor (pro-embryo), or any other organ rapidly absorbed, &c. 2. The division into fours by planes crossing at right angles is common to many other processes besides pollen formation, *e.g.*, the embryo itself. 3. Vesque's view as to the embryo-sac arising by fusion of several cells is not supported by the existence of the remains of the *two cap cells* above the embryo-sac—the remains of the supposed fusing cells.

Comparison of the Effects of the Frosts of 1860-61, *and of* 1878-9, by E. J. Lowe, F.R.S.—The greatest cold of 1860 exceeded that of last winter by 10°; it was 6° below zero in 1860, and 4° above zero in the late frost.

The present paper records the great difference in the effects in the two frosts at Highfield Honse, Nottingham:—

Name.	Frost of 1860.	Frost of 1878.
Acacia (long spined)	Slightly injured	Many boughs killed and was a month later coming into leaf.
Elm (broad leaved)	Uninjured	Three-quarters of boughs killed back at least 2 feet.
Bay (sweet)	Killed to the ground	The ends of the shoots only killed and all the leaves.
Deodar cedar	Became deciduous, otherwise uninjured	Not injured.
Arbutus	Killed to the ground	Half the branches killed, the others injured.
Aucuba	,, ,,	Uninjured.
Pampas grass	Killed	Killed.
Araucaria imbricata	Killed to where buried in the snow	Uninjured.
Yew	Slightly damaged	Slightly damaged.
Wellingtonia gigantea	Much injured	,, ,,
Evergreen oak	Many killed, all became deciduous	Uninjured.
Ivy	More or less injured	More or less injured.
Fennel	Uninjured	All killed.
Sage	Killed	Uninjured.
Roses (standards)	All killed	Many killed, nearly all injured.
,, on their own roots	Many killed	Uninjured.
Retinospora obtusa	Killed	,,
,, *squamosa*	,,	Slightly injured.
,, *leptoclada*	—	Uninjured.
,, *ericoides*	—	,,
,, *filifera*	—	,,
,, *plumosa*	—	,,
,, *plumosa argentea.*	—	Slightly injured.
Juniperus excelsa	Killed on the north half of the tree	Uninjured.
,, *chinensis aurea*	—	,,
Phormium tenax	Killed	Only killed to the ground.
Eugenia ugni	,,	Half the branches killed
Yucca gloriosa	,,	Slightly injured.
Cineraria maritima	,,	Killed.
Laurel, common	Many killed to the ground	Uninjured.
,, Portugal	Nearly all killed	,,
Holly	Most killed in the branches to the height of 7 feet	,,
Thuja aurea	Mostly killed	Slightly injured.
Cork tree	Killed	—
Deutzia gracilis	Scarcely injured	Uninjured.
Quince	Killed	—
Yew, golden	Slightly injured	Uninjured.
Pinus insignis	Killed	,,
,, *pigmy*	Slightly	,,
,, *menziesii*	Became deciduous, and had no leaves for a year	,,
,, *morinda*	Slightly injured	,,
Laurustinus	All killed	,,
Abies Nordmanniana	Uninjured	Lost half its leaves and some boughs.
Walnut	Boughs killed and one tree	Uninjured, except a want of vigour; leaves only half the usual size.
Apples	—	Leaves small, fruit scarce and remarkably small.

[1] *Ann. d Sciences Nat.*, 1878. [2] *Ann. d. Sc. Nat.*, 1878.

The above will sufficiently illustrate the effects of the frosts in two severe winters.

It is worthy of remark that instead of cold killing the slugs and various pests of plants, they were never known so numerous. Many hardy plants in pots were killed, such as ivy, *Pteris aquilina*, &c., when they escaped if plunged in the ground.

Recent Additions to the Moss Flora of the West Riding of Yorkshire, by Charles P. Hobkirk, F.L.S.—After treating of the work of the Yorkshire Naturalists' Union, in investigating the fauna and flora of the country, the author particularised some of the chief species found since 1873, and gave the history of them, viz., *Seligeria tristicha* at Littondale; *Aulacomnium turgiaum* at Whernside; *Fontinalis gracilis* at Malham Cove; *Plagiothecium nitidulum* at Penyghent, &c. Four lists were appended to the paper, viz.: (1) New species, 48; (2) Species found in fresh localities, 142; (3) Localities previously known, but not recorded, 29; and (4) Species inserted in error in previous list, 8; making the total number of species now recorded for the Riding, 327.

Department of Anthropology

Flint Implements from the Valley of the Bann, by W. J. Knowles.—I have obtained within the last three or four years, from the banks of the River Bann, a series of flint weapons or tools which differ considerably in type from the ordinary flint implements of the North of Ireland. They have been obtained from a deposit of diatomaceous earth used for brickmaking, near the town of Portglenone, and are of two types. That which is most numerous appears to have been been made by splitting up nodules into halves and quarters, and then forming these into rude pointed implements by a process of coarse chipping. This kind numbers upwards of fifty, and they all agree in having a cutting point and thick base for holding in the hand. They are as a rule long, narrow, and of a cylindrical form rather than broad and flat, but some of the latter kind occur. Some of the largest are 7 or 8 inches long and from 2 to 3 inches broad at the base, and there is one fine implement of the flat kind, very like the triangular palæolithic implements, which is 6 inches long, nearly 4 inches broad at the base, and 1½ inches thick. Dr. Evans, in "Stone Implements and Ornaments of Great Britain," mentions that he has found implements of palæolithic form on the shores of Lough Neagh, near Toome, and I have also found them there myself, but as Toome is only a little farther up the Bann, and the diatomaceous earth is found there, I believe they have been derived from that deposit by denudation.

The second set of objects may be described as large triangular flakes with a central rib down the back, and having the base wrought into a tang. In the Catalogue of the Royal Irish Academy this form of implement is represented in Fig. 3, the tang being looked on as the first step of development into arrow- and spear-heads; but I am of opinion that instead of showing a step towards greater perfection, these were perfect implements of their kind, and also manufactured specially for use about rivers.

There is no means of determining the age of these objects except we form some sort of estimate from the fact of their being found in a deposit underlying peat. If they are of neolithic age they are very interesting from being confined chiefly to a river valley, and not being obtained where other neolithic implements are found in abundance. This fact would, I think, suggest a reason for the large triangular flints of palæolithic age being chiefly confined to the old river gravels, while the implements of the same age from the caves are so different. The implements of the pointed kind in all cases might not be for general use, but chiefly for the river valleys. They may probably have formed weapons for attacking the larger animals when they came down to drink, but the theory that they were used for breaking holes in ice I think a very likely one. I believe the tanged flakes were used mounted probably for spearing fish, as suggested by Dr. Evans in "Archæologia," vol. xli. p. 401.

On the Relations of the Indo-Chinese and Inter-Oceanic Races and Languages, by A. H. Keane, M.A.I.—The conclusion arrived at by the author, is, that, excluding the dark races, there are in the Indo-Chinese and Inter-Oceanic area two fundamentally distinct racial types only—the yellow or Mongolian, and the fair or Caucasian; and corresponding to them two fundamentally distinct forms of speech only—the monosyllabic spoken *vario tono*, and the polysyllabic spoken *recto tono*. All the rest is the outcome of incessant secular interminglings.

Mr. Sydney B. J. Skertchly, F.G.S., H.M. Geological Survey, read a paper *On the Evidence of the Existence of the Palæolithic Man during the Glacial Period in East Anglia*. The object of the paper was chiefly to record the sections in which the author had discovered palæolithic implements beneath the chalky boulder clay in East Anglia. He said:—"The beds which yield the implements are a series of loams, clays, and sands, to which the author has given the name of Brandon Beds. They occur at the top of the middle glacial series of Messrs. S. V. Wood, jun., and F. W. Harmer, and underlie the chalky boulder clay or upper glacial of the above-named authors. They have yielded palæolithic instruments in many places, but only those will be described in which the chalky boulder clay overlies the Brandon Beds at the present time. Near Mildenhall, on the River Lark, in Suffolk, two sections have yielded implements. They are at Warren Hill and Mildenhall Brickyard. The section at Warren Hill is as follows:—1. Sandy soil, &c., two feet. 2. Chalky boulder clay six feet. 3. Gravel four feet. 4. Loamy clay four feet. 5. Boulder clay six feet. 6. Chalk. This spot has yielded great numbers of flakes and many implements. It was originally described by Professor Prestwich, but the boulder clay has only recently been exposed above the tool-bearing loams. At Mildenhall Brickyard the section is—1. Sandy soil one foot. 2. Chalky boulder clay six feet. 3. Loam ten feet. 4. Chalk. From this place many implements and flakes have been obtained. They occur in the loam. Culford in Suffolk: The Brandon beds are here dug under fifteen feet of solid boulder clay; from these I obtained two flakes. West Stow, in Suffolk: Boulder clay overlies, underlies, and wraps round the Brandon beds at this place; some well-worked implements have been obtained, one of which was dug out by the author. Brandon: Near Brandon the same beds are being dug beneath boulder clay, and have yielded very good implements. The peculiarities of the implements are pointed out, and the mode of distinguishing them from specimens from the gravels is indicated. The author in this paper merely desires to emphasize the fact that from several sections he has himself dug out palæolithic implements from below tough, undisturbed chalky boulder clay. These proved the existence of man in these districts previous to the glacial periods.

The Chairman said that if Mr. Skertchly's facts were sound and his inferences well warranted it was obvious to all the matter was one of the greatest importance. He invited discussion.

After some remarks from Dr. John Evans, Prof. W. Boyd Dawkins (Manchester) said there was no evidence that the glacial period was to be looked on as a dividing line in classification. He fancied that all the animals that were living after that period of extreme cold had passed away appeared in Europe before that cold was felt, and he could not therefore, look on the glacial period as a hard and fast line. It seemed to him if they applied that consideration to the examination of the question of the antiquity of man there was no *à priori* reason for supposing that man was not here in the pre-glacial age. Seeing that animals were living in Europe before the cold period arrived at its maximum, it was probable that man was here too. Man was living in the south of this country when the area north of the Thames was submerged—when the sea there was bearing icebergs which were accumulating the boulder clay.

Sir John Lubbock, said that as geologists they must be careful before they came to any definite conclusions on a matter of this importance. He confessed that after listening to the paper which they had just heard he felt considerable difficulty in resisting the conclusions which Mr. Skertchly had drawn from the facts. He thought there could be no doubt that the implements before them were the work of man.

Professor Huxley said that without the slightest desire to discourage the excellent efforts Mr. Skertchly had made, he confessed he could not attach any great importance as to whether those particular deposits were post-glacial, inter-glacial, pre-glacial, or how. There was not the slightest doubt that at the end of what was commonly recognised as the tertiary period there was a time in which the climate of this country became extremely severe—there was a great formation of ice. There was no doubt that the animals which existed in this part of the world immediately before that deposit, were practically the same as those just after. If they looked at the glacial epoch as a period

of duration of animal life—the period it occupied was totally insignificant in regard to that which they would require for the evolution of man to his present state. There could not be the slightest reason for supposing that pre-glacial man was in any way different from post-glacial man. No doubt, whatever habits of life were adopted during the cold period, were adopted before that cold fairly set in. As the people lived like Equimaux during the whole of the cold period, and for some time afterwards, he could not see why they should not have lived in that fashion for some time before. There could not be a doubt in any reasonable man's mind, that the remains of man discovered in the older part of the glacial deposit were the same as those in the new. The evidence Mr. Skertchly had brought forward was very satisfactory, but he confessed he did not see why it should not be so.

Mr. Skertchly read a paper *On a New Estimate of the Date of the Neolithic Age.*—The Fenland occupies an area of 1,300 square miles around the great bay of the Wash. The surface of the inland portions consists of peat, and that of the seaward parts of marine silt. This silt is still in process of deposition, and the land is consequently gaining upon the sea. From the time of the Roman occupation, at least, banks have been successively erected to reclaim the newly-formed ground; and as the dates of these banks are known, very accurate estimates can be formed of the rate at which the deposition is going on in different parts. The maximum rate is fifty-nine feet per annum, and four miles of new land has been formed since the oldest banks were erected. These banks are generally ascribed to the Romans; but they are probably British. In this estimate they will be taken as Roman, in order that the age may not be over estimated, and the maximum rate of deposition will also be used as giving the minimum of time. The geological evidence shows that as the silting went on, and the area become converted into land, peat grew and gradually spread over the newly-formed ground. But in process of time the climate became unfitted for the growth of peat, which gradually lost its vigour, and finally ceased to form. Hence a wide stretch of silt land borders the Wash, upon the surface of which no peat has ever formed. The peat died upon its eastward march; the silt still travels on. The nearest approach of the peat to the banks along the line of most rapid accumulation is twelve miles distant therefrom. The age of this, the newest peat in the Fenland, can be thus determined. Between the "Roman" banks and the sea lie four miles of silt, which has taken 1,700 years to accumulate. Between these banks and the sea lie twelve miles of silt, which at the same rate of formation would take 5,100 years to accumulate. Adding 5,100 to 1,700 years, we have 6,800 years as the least possible age of the newest peat. This peat has yielded many neolithic implements, hence we may assume that 7,000 years will take us back into the neolithic age. The coincidence of this estimate with the two Swiss ones above-mentioned is remarkable. These results do not, however, give us the date of the introduction of the neoliths into Europe, for neither in the Swiss nor English localities are we sure that the neolithic relics belong to the early part of the neolithic age. The author, indeed, has recently obtained evidence of neolithic handiwork in Fenland peat of far greater age than that described, the peat bed underlying silt more than 7,000 years old. He is inclined to think that the neolithic age in England began at least 10,000 years ago, and perhaps 20,000 years; but that it does not approach the close of the glacial epoch seems to be shown by the fact that the older Fenland beds (themselves post-glacial) do not contain human relics.

Commander Cameron read an interesting paper giving a detailed account of the *Manners and Customs of the People of Urua, one of the largest Native States in Central Africa.* This particular race maintained many places in which religion was centralised. Kasango, the king or principal chief, was not merely a secular chief, but was also intimately mixed up with the religion of the people. He claimed divine praise, and at his death was buried with savage rites, and all his wives except one were slaughtered at his grave. This one remained to be the pythoness of his successor, and the spirit of the chief at his death was supposed to be transmigrated into the body of his successor. An idol was preserved in the middle of a dense jungle. He had for a wife one of the sisters of the reigning sovereign. Around about the jungle were the huts of a numerous class of priests, who received the tribute collected for that class of people. The only person allowed to sacrifice to the idol or to visit him except the idol's wife was the sovereign of the country. There was a numerous class of wizards who carried about with them small idols and a large stock-in-trade in charms, which they sold. Many of them were ventriloquists, and it often happened when they were consulted by the natives questions were asked which were communicated to the idol, and then the wizard, by the exercise of very poor ventriloqnism, made the idol return an answer to the question put. The caste was very clearly defined in this race. The chief allowed none of his subjects to sit down in his presence without permission, and he seldom accorded it. No one of a lower grade could sit down in the presence of one of a superior grade. The customs in eating, drinking, and cooking were various. They declined to eat in the presence of each other, and, although fond of the native beer, they would not drink it while anybody was looking on, although it was sufficient to hold up a cloth as a screen. All the different castes and ranks were marked and distinguished by their dress. The attire was very simple, consisting usually of an apron. They were not a hairy race, but managed to grow their beards very long, and they plaited them after the manner of a Chinese pig-tail, winding up with a ball of dirt at the end to make it hang down straight. The women were tattooed most extensively. The means of communicating news was by drums and messengers. The men could run very fast. One man, for instance, brought him a message from the king, having come a distance of between 50 and 60 miles in a period of six hours. By means of certain beats on the drum messages could be sent immense distances, and answers immediately returned. In time of war the king could send messages to a great distance, either to bring up his forces at once, or to say that he was returning and that they were to go back.

Major Serpa Pinto read a paper *On the Native Races of the Head Waters of the Zambesi.*—He said they there found people whose complexion, as compared with his, then bronzed with an African sun, was white, yet they were negro in feature. There were also mixed races in that part of the country, with complexions of a whitish cast, yet with negroid features. The whole matter seemed to indicate in a most puzzling way the mixture of races. In the Bihé district, that portion of the population had, for the most part, made its appearance during the last century. It was not a pure African, but probably a mixture with the races which came over for elephant hunting purposes. The pure African type, of course, was the flat nose, large lips, and frizzled hair; but there had been some modifications in this instance with regard to feature. He declared that he had seen girls in that part of the country who, if their complexions had been more like that of the Europeans, would have passed for beauties here.

M. Brazza read a communication *On the Native Races of the Gaboon and the Ogowé.*—Major Pinto, he said, had spoken of races having European characteristics. He was of opinion that those people had come from the North of Africa, because under the name of Ubamba he had found races very much resembling them to the south of the Congo. The negroes Major Serpa Pinto saw were probably the advanced guard of an invasion which had overrun the country to the east of the Gaboon. Stanley spoke of a great emigration, very much resembling what had taken place among the Fan cannibals. There had been much talk indulged in adverse to the cannibal races of this part of Africa. Du Chaillu, who had visited for one day only one of the Fan villages, had given a description of this race which had been too much influenced by accounts he had received from a tribe at war with the cannibals. He had said that in their villages he had found quarters of human flesh exposed for sale; that they killed and ate their prisoners of war, and that they sold the bodies of their own dead who had died of disease to their neighbours. M. de Brazza denied the truth of such accounts. As a proof that the Fans had kindly and generous sentiments he told how a Fan chief had been kind to him when he was obliged to leave his people sick in the bush. He owed his life to the Fan chief, and he should always be grateful to him and his people. He wished therefore to do all he could to remove the prejudice against the Fans which had been excited by Du Chaillu. They were a very generous, courageous people. It was true they were cannibals—that they ate their prisoners of war; but it was with them a religious idea,' for they believed that in eating the heart of a brave man the courage of the dead passed into themselves. M. de Brazza also gave an interesting sketch of the Akkas, a dwarf race he found scattered up and down among the different peoples, like what the Jews or the gipsies were in Europe. The height of the Akkas was from three to four feet.

Mr. V. Ball, M.A., of the Geological Survey of India, in continuation of some remarks make on this subject at the last meeting of the Association in Dublin, gave an account of the results at which he had since arrived from an examination of all the available data. These were that the three classes into which the stone implements might be grouped occupied independent geographical tracts which overlapped one another towards the centre of the peninsula. The geographical tracts characterised by the prevalence of one or other of the particular forms when laid down on a map showed a remarkable coincidence with the limits of the areas of distribution of the non-Aryan races belonging to the several families whose waves of imigration had contributed to form the lower strata of the population. Thus the manufacturers of the polished Celts were identified with the Kolarian races who entered India from the north-east and Burmah. On the other hand, the manufacturers of the flakes and cores of flint, &c., appeared to have entered the peninsula from the north-west, and to have belonged to the Dravidian family. The identity of the manufacturers of the chipped quartzite implements which were found in Southern India, was less clear, but suggestions regarding it were also offered by the author.

SECTION E—GEOGRAPHY

Mr. C. E. D. Black, read a paper *On the Geography of the Upper Course of the Brahmaputra.*—With especial reference to a recent important exploration of the easternmost portion of its course, made by one of the native explorers attached to the Indian Survey Department of this piece of work, though executed in 1877, no description had reached Europe, and its communication for the first time to the British Association was therefore a geographical event of very great interest. Mr. Black commenced by tracing the topography of the great Sanpee river from its source 15,000 feet above sea level in Western Tibet, over lofty plains, past the towns of Janglache, Shigatze, to the furthest eastern point to which it had been traced by the famous Indian explorer, Pundit Nain Singh, noticing *en route* the remarkable hot springs in the valley of one of the northern tributaries, the Shiang-chu, and the various rivers which join it on the left and right banks. The plain and city of Lhasa, the residence of the Dalai Lama and of the Chinese governors or agents, was described, as well as the amusing incidents accompanying the transit of the river on the occasion of that eccentric traveller, Mr. Manning, proceeding to Lhasa. From Chetang eastward commenced the new work of the explorer, N——g, who had been commissioned by General Walker, the Surveyor-General of India, to explore the course of the Sanpee for as great a distance as possible. Crossing to the north bank of the river, he followed it for a distance of 30 miles, nearly to the confluence of the Milk-chu, a small stream. Here he diverged to the north-east, making a detour of 50 miles, while the river wended its way for 20 miles through impenetrable mountains. The most remarkable feature of the exploration was the discovery that the river made a huge bend northwards before commencing its south-eastern course into Assam. This bend was actually surveyed by the explorer. From his furthest point to the highest known point of the Dihong, an unsurveyed gap of about only 100 miles now remains. Mr. Black concluded by pointing out that this great bend, which was previously unknown, now leaves room for a northern feeder of the Subansiri, and thus accounts for the large bulk of the latter river. Mr. Black also cited some important corroboration of this new fact, afforded by the Abbé Desgodins' researches, and by the recent measurement of the discharges of the large rivers of Assam by Lieut. Harman, R.E.

Prof. P. J. Veth, president of the Dutch Geographical Society, contributed a paper, giving interesting details of the *Dutch Expedition to Central Sumatra.*—The most important result of the expedition was the gain in knowledge of the great extent and capabilities of the Batang-Hari, which is found to be about 210 miles in length in a straight line, and over 490 miles following its windings, being in fact larger than the Musi or Palembang, hitherto considered the only large river in Sumatra. It is practicable for small prahus, used in transport of merchandise, for 480 miles; and the steam launch drawing 3½ feet could navigate it for 370 miles, both these distances far exceeding the navigable portion of the Musi. Its tributaries are also navigable for boats, and one of them at least for the launch. The population of its district as a whole is scanty, yet there are numerous villages close to each other; cattle abound in the highlands, and coffee is largely cultivated in Karinchi. The importance of the river as a highway for the eastern parts of the West Coast Government and the inland districts of Jambi and Karinchi does not therefore merely depend upon its fitness for transport of coal from the Ombilin Valley.

A paper by Major Pinto was read *On his Journey across Africa*, in which, though he did not tell much that was new of his exploration, he referred to one or two points of some scientific importance. He was desirous of calling the attention of the Section to the manner of determining the longitudes by the eclipses of the satellites of Jupiter, and he suggested a means of overcoming an obvious difficulty. Let it be resolved, he said, that in one of the many official observatories that had the support of Europe the eclipses of the satellites of Jupiter be studied without interruption, and the solitary explorer, lost, so to speak, in the enormous solitudes of the dark continent, when he in the obscurity of night saw the little brilliant speck disappear, would know that in a position perfectly determined some other person likewise at that same moment saw the small satellite disappear, and he will have the consciousness that on his return to Europe he will meet with the necessary elements to determine as many strictly correct longitudes as were the observations he might have made. When the planet was in conjunction the telescope might be turned toward the star that hid itself, or by making a series of apozenites of the moon they would obtain their longitudes. Any explorer of tropical Africa once provided with the aba and a telescope of 4 feet focal distance would find himself in a position to determine two of the co-ordinates and any variations of the compass. Major Pinto further recommended the hypsometer and aneroids for altitudes. Major Pinto gave a short *résumé* of the meteorological conditions of the Zambesi. He explained that the banks of the upper part of the river were of a fine and white sand of a remarkable character; when trod upon it produced a queer sound resembling somewhat the crying of a young child. The range of the Catongo mountains was well peopled on the westward, and it was there the Barotzes made their plantations, which consisted of maize, sweet potatoes, pumpkins, and mandisca. The great plain was not availed of for agriculture. Around the lakes and some other places a kind of grass grew, upon which thousands of oxen might be seen grazing. The Luinas followed the calling of shepherds. Horses could very easily be bred there, and the Barotzes possessed a splendid specimen of hounds, with which the natives hunted the antelope. The human race at present populating the country was a true mixture of the Lobares, Luinas, and Janguellis. The makalotus had now disappeared completely. Polygamy prevailed, and, contrary to what occurred in most other tribes, women who were held to be noble enjoyed high consideration and were sometimes invested with the exercise of public functions. The Barotzes possessed a tolerable quantity of firearms, but their natural arm was the assegai. They were rather industrious and good tanners, but did not use the knife, doing all their work with the blade of the assegai.

Several important papers on Afghanistan were read in this section by officers and others who had been with the English army in the recent Afghan war.

Mr. William Simpson, the special artist of the *Illustrated London News*, read a paper, entitled *Afghan War—the Jellalabad Region.*—The tendency of his explorations, beyond his own proper sphere as an artist, was rather archæological than geographical. No account of the Jellalabad Valley would be complete without some notice of the Buddhist remains to be found there. He was aware previously of the existence of these remains, but what astonished him was the vast quantity of them still to be seen. On all sides are extensive mounds and heaps, that being the condition in most cases of these remains. Here and there structures may be found, which, although in ruins, yet bear on them some traces of architecture. One point is apparently clear, that in the Buddhist period the population of the Jellalabad Valley must have been much more numerous than at present, and that the area of cultivation must have been also more extensive. Major Cavagnari supplied the author with a working party to make excavations at the Ahin Posh Tope, about a mile south from Jellalabad. The principal object was to explore the architectural details of the remains, but while thus engaged, the author penetrated, by means of a tunnel, cut for about 45 feet through solid masonry, to the central shell of the shrine, and found along with what were most probably the ashes of some Buddhist saint of high repute, twenty gold coins,

each about the size of a sovereign. Seventeen of these were Bactrian, or Indo-Scythian; and three were Roman.

Major Campbell described the *Shorawak Valley and the Toba Plateau in Afghanistan*.—The Shorawak valley had never been visited by Europeans before the recent campaign. It is a narrow strip of flat country lying between the desert on the west and north-west, and a range generally known as the Sarlat Hills to the east. Its total length is about 40 miles, with a width of 10 miles at the northern end; and it is 3,250 feet above the sea. The head of the valley, to the north, is closed in by the southern spurs of the Khwaja-Amran range of mountains, which nearly join the north-western spurs of the Sarlat Hills, only leaving a gap of about a mile through which the Lora river runs into the valley. The valley is thickly populated, and crops of wheat and barley are raised. Major Campbell suggested that Shorawak was once a lake, which was gradually silted up by deposits from the Lora, and this seems to account for most of the phenomena. The river, after flowing through the valley, is swallowed up in the sand of the desert. The Toba tableland is at the north-eastern extremity of the Khwaja-Amran range of mountains. The general elevation is over 7,000 feet. Major Campbell gave an interesting account of this plateau and of its inhabitants. It will probably form an excellent hill sanatorium for the troops stationed in the Pishin Valley. The climate of the plateau in summer is very pleasant.

Papers were also read *On New Routes to Kandahar*, by Captain Haldich; *On Surveys Around Kandahar*, by Captain M. Rogers, R.E.; and *On the Orography of the North-West Frontier of India*, by Mr. Trelawny Saunders.

Mr. Black read a paper, which had been contributed by Mr. J. O. N. James, deputy superintendent of the Surveys of India. The object of the paper was to sketch out, in a concise manner, the nature of the work in progress and already performed by the Indian Survey Department, and to point out its practical utility. During the administration of Sir Henry Thuillier, late Surveyor-General of India (1861 to 1877), an area of not less than 290,000 square miles was surveyed and mapped, including the wildest and least known tracts of India. This enormous area, more than double the size of Great Britain and Ireland, was surveyed in sixteen years at an average cost of *2l.* per square mile. Also an area of 493,000 square miles was completed on the village survey system on a scale of four inches to the mile, and 12,281 square miles by cadastral measurement on a scale of 16 and 32 inches to the mile; making an aggregate of 505,574 square miles, considerably more than double the area of France. The revenue surveys comprise a great portion of Bengal and Assam, all Oudh, part of the North-West and Central Provinces and Bombay, nearly all the Punjab, and all Sind. There is not a single official in India who does not possess maps of the portion of the country included in his jurisdiction, which are suited to every present requirement. The maps issued by the Surveyor General's Department are also utilised by engineers in the construction of public works, by the foresters for conservancy purposes, by mining companies, planters, holders of estates, and by every branch of the civil and military services for purposes too numerous to detail.

SECTION F—Economic Science and Statistics

Papers were read in this Section by Dr. Gladstone *On Elementary Natural Science in the Board Schools of London*, by Mr. Miss, of the Sheffield School Board, on a similiar subject, and by Mr. Hance, of the Liverpool School Board, describing the successful efforts made by them in science teaching. In the interesting discussion which followed, Mr. F. Wilson observed that what they required was the introduction of the science of perception. A child could see a thing and not always perceive it, therefore it was most essential that they should teach scholars to perceive and so obtain a system of order.

Dr. R. Wormell remarked upon the importance of having teachers who knew something about the teaching of science in the beginning, and spoke of the necessity of a college where teachers could be instructed in order to carry on the work of scientific teaching. There were 1,600 young men entering the training colleges every year, and at least 100 of these would do better as teachers of science than of other subjects. Scientific education ought to find its way into all schools from the earliest stages to the most advanced. The Kindergarten system was a fair beginning, but it was too restrictive. Observation and experiment were the means by which truth had to be discovered, and when science was taught simultaneously with other subjects they would find that the intelligence of the pupils was heightened, and that their skill in manipulation, and ability to use their hands, would increase, no slight point when it was remembered that the manufacturing population were educated in these schools. It would, in his opinion, help such bodies as the London School Board, who were anxious for this scientific teaching, if the British Association had a permanent committee to consider the question and give assistance if required.

The Rev. A. Harland referred to the difficulties of teaching natural science in the country school. It was not only necessary, he said, that our teachers should have a thoroughly scientific knowledge, but that the inspectors of the schools should also possess it. So little encouragement had the inspector given that he had even told them in their school to drop such subjects as botany, and to confine their attention pretty much to the three R's. He had, however, an evening with the village children, when he tried to give them some knowledge of chemistry and physiology in order to show them the evils of intemperance, and he thought this was much better than making them commit to memory silly recitations, as was the practice in some Bands of Hope.

Miss Becker (Manchester School Board), after remarking that the question of giving children scientific teaching was only valuable as to the help it would give them in making their way through the world, said she was sorry the science of mechanics was confined to the boy's school because any girl or woman who had to do household work was painfully conscious that she had frequently to move weights, and if she understood the principles of mechanical science it would be far less laborious and less painful—in fact, the principle of the lever was of the utmost consequence in domestic economy. The scrubbing of a floor, and the carrying of a coal-box were mechanical operations which were much better done on scientific principles. Animal physiology had a very close relation to the infant's organisation in its most tender stages, and in the interests of the babies she did think it most important that the common elementary principles of physiology should be known to their mothers.

After some further remarks by Miss Becker, showing the value of a knowledge of science in the commonest duties of every-day life,

Prof. Silvanus Thompson spoke of the advantage of apprenticeship schools, but said that if such schools were established in England it would be by local, rather than Imperial effort, for they succeeded better when they were not fettered by Imperial legislation. Whatever science teaching existed was not merely a scrap, but part of the organic whole, and this was sufficiently elastic to allow of there being special schools, a building school, a school of carpentry, a school for other kinds of technical education, all having their base in the elementary schools; but there should be more community of idea between the lower and the higher scientific training. Miss Becker had affirmed that children seven years old ought to be able to read perfectly if they were scientifically taught, but they were not scientifically taught, nor did he think the difficulty would be removed until they had done away with the abominable irregularities of the detestable English spelling, and reformed the table book.

The Rev. W. Delaney (St. Stanislaus College, Tullamore) said he should like to change the idea that science was merely the handmaid of education, for he believed it was really the best educational weapon, and as a schoolmaster he valued almost infinitesimally the knowledge that boys and girls, and even university men, carried with them into life. Education hitherto had gone too much in grooves, and what they required was a great improvement in scientific teaching, especially in intermediate schools, where it was in a deplorable state. He found that boys who could learn nothing learn science easily, and that when they had learnt science they could learn other things easily. There was an absolute inutility and absurdity in teaching grammar in which boys were taught to know the unknown by the unknown, and he found moreover that whilst Latin and Greek were well known in scientific schools, scholars simply studying the classics often failed in that special study, whereas those who studied science as well as classics passed often at the head of the list.

The President (Mr. Mundella) in summing up the discussion, said he believed that science teaching tended to redeem school life from its drudgery and monotony. In the science schools abroad the interest manifested by the children in a proper object lesson, and the facility with which they acquired knowledge, had very much struck him. The step which, above all others,

was the most necessary in education was to awaken the interest of the children in the subject taught. The children would be taught to think for themselves. Therefore, he had always supported science teaching in schools not only for its great utility, but from a belief that if science teaching was coupled with the ordinary literary teaching of schools, a knowledge of the literary subjects would be more easily acquired. It did not surprise him to hear that there was a good deal in our national education system that needed reform. They had just heard from a successful and accomplished teacher in this town that science could not be taught, because the inspectors themselves discouraged the teaching of it. Young gentlemen fresh from the Universities—some of them very accomplished—were made the inspectors of the whole elementary schools in the country, by a system of patronage and not of selection. They were very highly paid, and they were appointed inspectors because perhaps their fathers or near relatives had rendered a service to some particular political party whichever it might be. But that was altogether a wrong state of matters with reference to education. In London he was now constantly hearing a cry as to whether we are not over-educating the people. Although all present might acquiesce to-day in this discussion, throughout society the cry was, "We are over-educating our people." The real truth was, that people had yet to learn to begin to educate children. They were all very proud of what had been done by the Education Act of 1870, and he should be the last man to undervalue that Act. But as for having an educational system, he declared they had none. To begin with, they should have a Minister of Education who would deal with education solely, and who would know something about his business. Education ought not to be mixed up in the Education Department with vaccination and cattle plague, and other things. It seemed that all the heterogeneous things there was no room for in other departments had been sent to the Education Department. He not only supported science teaching in schools, but he wanted to see it carried to a higher state than the mere teaching of it in schools. Should the British Association visit this town some twenty years hence, they might reasonably expect to find "home-bred" scientific men who would appreciate more highly the Association's labours.

Prof. S. P. Thompson read a paper *On Apprentice Schools in France*.—The problem to be solved was—how to give that technical training and scientific knowledge to artisan children which their occupation demanded, without detaining them so long at their schooling as to give them a distaste for manual labour. There were four solutions of the problem, all of which had been tried, and illustrations of which could be seen in Paris. They were (1) send the children to work in the factory or workshop at an earlier age, making it obligatory all through their apprenticeship that they should have every day a certain number of hours' schooling in a school in the workshop or attached to it. (2) Keep the children at school as long as their education was unfinished, but set up a workshop in the school where they should pass a certain amount of time every day so as to gain at least an aptitude for manual labour. (3) Organise a school and a workshop side by side and co-ordinate the hours given to study with an equal number of hours devoted to systematic manual labour; and (4) send the children half the day to the existing schools, and the other half to work half-time in the workshop or factory. Schools of the first type had existed in France for nearly thirty years, and at the close of 1878 there were no fewer than 237 schools of this character. So far as he was aware, there was only one school of the second type—the Ecole communale d'Apprentis, in the Rne Tournefort, Paris. The peculiarity of this school was that workshop training was being given to lads who had not yet completed a course of elementary education. Of the third type some admirable examples were to be seen in Paris. Some very interesting particulars were given of the progress of the horological school at Besançon. The fourth type or half-time school, which was English in its origin, was rarely to be found in France. Since the old apprenticeship had virtually lapsed, there was nothing to save the young artisan of the rising generation from degenerating into a mere machine, unless a new agency could be practically organised. What was claimed for the apprenticeship school was that its pupils do not possess just a bare minimum of knowledge sufficient to procure them means of subsistence in one narrow department of one restricted industry, but that they possess both manual dexterity and a fair technical knowledge which would enable them not only to earn more and to turn out better work, but also to be less at the mercy of the fluctuation of trade for the means of subsistence. Besides the new apprenticeship being better for real instruction in technical principles, it was also better for practical work in so far as it shortened the needlessly long years of the apprenticeship, and imparted at an earlier age all the manual capacity that apprenticeship in any form could impart. There were not wanting on our horizon signs of significance in the problem of the relation of science to labour. We had really skilled workmen, and no foreign workmen were their equals, but they were only units in a crowd. Take which view they would, technical education, and above all, the technical education of the artisan classes was a *sine quâ non* of the future industrial prosperity of Great Britain. What steps then must be taken to give effect to the new apprenticeship? Two things would determine the success or failure of the school—(1) the obtaining of the right kind of teachers, and (2) the adoption of a system of instruction based upon drawing, which was the language of the manufactures, the handicrafts, the constructive industries of all kinds. It was evident that the first step would be the foundation of a system for training competent teachers. Then there must be a central technical college, for through such an institution alone could community of thought and method of work be obtained. If such a system of technical education as he pointed out was to be instituted, the nation must move towards its accomplishment with a spirit very different from that in which it had viewed technical education during the last quarter of a century. Crisis after crisis had passed, and capitalists and unionist artisans either would not, could not, or dare not confess that the core of all the rottenness was the failure of the old apprenticeship to cope with the requirements of the age and the new social conditions brought about by the fierce rivalries of industry.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE twenty-eighth meeting of the American Association for the Advancement of Science was commenced on Wednesday, August 27, at Saratoga Springs, N.Y. After the formal opening in the Town Hall, the proceedings of the first day were mostly concerned with organisation. We give below, in part, the address of the retiring president, Prof. O. C. Marsh, which was delivered on the evening of the 28th, and we hope shortly to offer further intelligence of the scientific work of the meeting.

The new President is Prof. George F. Barker, of Philadelphia; the Vice-president in Section A (comprising Mathematics, Astronomy, Physics, Chemistry, and Mineralogy), Prof. Langley, of Alleghany; and that in Section B (Geology, Zoology, and Botany), Major Powell, of Washington. Prof. Clarke was chairman in Chemistry (sub-Section C), Dr. Morley in Microscopy (sub-Section D) and Dr. D. Wilson in Anthropology (sub-Section E). In addition to the presidential addresses and ordinary work of the sections, we note from the programme that Dr. Edison was to give, on the Saturday evening, an illustrated paper on "The Electro-Chemical Telephone;" while Monday evening was to be devoted in general session to hearing three papers by Professors Chandler, Hall, and Hunt on the mineral waters of Saratoga. There is a goodly list of over 150 papers to be read before the various sections (and it is, by the way, a commendable feature, that the time each would occupy in reading is exactly stated). The following are, briefly, some of the subjects:—In Section A: Experimental determination of the velocity of light (Michelson); Cooling of the sun and the earth (Peirce); Solubility of ozone (Leeds); A general law indicating the location of planets, satellites, or annular rings round their primary (Marsden); Metrology and the progress of science (Barnard); Double stars (Hall); Identity of lines of oxygen with bright solar lines (Draper); Binaural audition (Bell); Conversion of mechanical energy into heat by magneto-electric machines (Barker); Phenomena of heating metal *in vacuo* by means of an electric current (Edison); Influence of light on electric conductivity of metals (Wright). In Section B: Succession of glacial deposits in New England (Upham); Histology of insects (Minot); Conditions to be fulfilled by a theory of life (Minot); Philosophy of the pupation of butterflies (Riley); Consonantal expression of emotion (Blake); Microscopic crystals in the vertebra of the toad (Bolton); The inter-oceanic canal problem (Lull); Bornean orangs (Hornaday); Objects of sex and of odour in flowers (Meehan); Remarkable crinoidal form recently found in Tennessee (Safford); New unpolarisable elec-

trodes for physiological research (Bowditch); Triassic rocks of New Jersey (Cook); Geological action of the acid of humus (Julien); Anatomy of the cat's brain (Wilder); Anthracite coal-fields of Pennsylvania, and their rapid exhaustion (Sheafer); Development of neuration in the wings of insects (Scudder). In sub-Section C: Reduction of carbonic acid by phosphorus at ordinary temperature (Leeds); Deterioration of library bindings (Nichols); Variations in temperature and chemical character of the water of Fresh Pond, Mass. (Nichols); Revision of the atomic weights (Clarke); Results of systematic analysis of air (Morley); Meteorological conditions of beet-root culture (McMurtrie). In sub-Section E: Superstitions of ancient inhabitants of the Mississippi valley relative to rabbits, serpents, owls, &c. (Henderson); Archæological notes from Japan (Morse); Ethnical influences of physical geography (Wilson); The sign language of the North American Indians (Mulbery); Archæology of the Champlain valley (Perkins); Ethnology of the islands of the Indian and Pacific Oceans (Bickmore); Pottery and stone implements of the southern mound-builders (Putnam).

Excursions were arranged to Luzerne, Lake George, Ausable Chasm, Howe's Cave, Montreal, Rutland, Port Henry, and Plattsburgh. On presentation of certificates, members could make free use of the wires of the Western Union Telegraph Company. They could also purchase at nominal rates tickets entitling them to all the privileges of the Congress Spring Park, day or night.

HISTORY AND METHODS OF PALÆONTOLOGICAL DISCOVERY[1]

IN the rapid progress of knowledge, we are constantly brought face to face with the question, What is Life? The answer is not yet, but a thousand earnest seekers after truth seem to be slowly approaching a solution. This question gives a new interest to every department of science that relates to life in any form, and the history of life offers a most suggestive field for research. One line of investigation lies through embryology, and here the advance is most encouraging. Another promising path leads back through the life history of the globe, and in this direction we may hope for increasing light, as a reward for patient work.

The plants and animals now living on the earth interest alike the savage and the savant, and hence have been carefully observed in every age of human history. The life of the remote past, however, is preserved only in scanty records, buried in the earth, and therefore readily escapes attention. For these reasons, the study of ancient life is one of the latest of modern sciences, and among the most difficult. In view of the great advances which this department of knowledge has made within the last decade, especially in this country, I have thought it fitting to the present occasion to review briefly its development, and have chosen for my subject this evening, THE HISTORY AND METHODS OF PALÆONTOLOGICAL DISCOVERY.

In the short time now at my command, I can only attempt to present a rapid sketch of the principal steps in the progress of this science. The literature of the subject, especially in connection with the discussions it provoked, is voluminous, and an outline of the history itself must suffice for my present purpose.

In looking over the records of palæontology, its history may conveniently be divided into four periods, well marked by prominent features, but, like all stages of intellectual growth, without definite boundaries.

The first period, dating back to the time when men first noticed fossil remains in the rocks, and queried as to their nature, is of special interest in this connection. The most prominent characteristic of this period was a long and bitter contest as to the *nature of fossil remains*. Were they mere "sports of Nature," or had they once been endowed with life? Simple as this problem now seems, centuries passed before the wise men of that time were agreed upon its solution.

Sea shells in the solid rocks on the tops of mountains early attracted the attention of the ancients, and the learned men among them seem to have appreciated in some instances their true character, and given rational explanations of their presence.

The philosopher Zenophanes, of Colophon, who lived about 500 B.C., mentions the remains of fishes and other animals in the stone quarries near Syracuse; the impression of an anchovy in the rock of Paros, and various marine fossils at other places. His conclusion from these facts was, that the surface of the earth had once been in a soft condition at the bottom of the sea; and thus the objects mentioned were entombed. Herodotus, half a century later, speaks of marine shells on the hills of Egypt, and over the Libyan desert, and he inferred therefrom that the sea had once covered that whole region. Empedocles, of Agrigentum (450 B.C.), believed that the many hippopotamus bones found in Sicily were remains of human giants, in comparison with which the present race were as children. Here, he thought, was a battle-field between the gods and the Titans, and the bones belonged to the slain. Pythagoras (582 B.C.) had already anticipated one conclusion of modern geology, if the following statement, attributed to him by Ovid, was his own:[1]

> Vidi ego quod fuerat solidissima tellus,
> Esse fretum: vidi factas ex æquore terras:
> Et procul a pelago conchæ jacuere marinæ.

Aristotle (384-322 B.C.) was not only aware of the existence of fossils in the rocks, but has also placed on record sagacious views as to the changes in the earth's surface necessary to account for them. In the second book of his meteorics, he says: "The changes of the earth are so slow in comparison to the duration of our lives, that they are overlooked; and the migrations of people after great catastrophes and their removal to other regions, cause the event to be forgotten." Again, in the same work, he says: "As time never fails, and the universe is eternal, neither the Tànais, nor the Nile, can have flowed for ever. The places where they rise were once dry, and there is a limit to their operations: but there is none to time. So of all other rivers; they spring up and they perish; and the sea also continually deserts some lands and invades others. The same tracts, therefore, of the earth are not, some always sea, and others always continents, but everything changes in the course of time."

Aristotle's views on the subject of spontaneous generation were less sound, and his doctrines on this subject exerted a powerful influence for the succeeding twenty centuries. In the long discussion that followed concerning the nature of fossil remains, Aristotle's views were paramount. He believed that animals could originate from moist earth or the slime of rivers, and this seemed to the people of that period a much simpler way of accounting for the remains of animals in the rocks than the marvellous changes of sea and land otherwise required to explain their presence. Aristotle's opinion was in accordance with the Biblical account of the creation of man out of the dust of the earth, and hence more readily obtained credence.

Theophrastus, a pupil of Aristotle, alludes to fossil fishes found near Heraclea in Pontus, and in Paphlagonia, and says: "They were either developed from fish spawn left behind in the earth, or gone astray from rivers or the sea into cavities of the earth, where they had become petrified." In treating of fossil ivory and bones, the same writer supposed them to be produced by a certain plastic virtue latent in the earth. To this same cause, as we shall see, many later authors attributed the origin of all fossil remains.

Previous to this, Anaximander, the Miletian philosopher, who was born about 610 years before Christ, had expressed essentially the same view. According to both Plutarch and Censorinus, Anaximander taught that fishes, or animals very like fishes, sprang from heated water and earth, and from these animals came the human race; a statement which can hardly be considered as anticipating the modern idea of evolution, as some authors have imagined.

The Romans added but little to the knowledge possessed by the Greeks in regard to fossil remains. Pliny (23-79 A.D.), however, seems to have examined such objects with interest, and in his renowned work on Natural History gave names to several forms. He doubtless borrowed largely from Theophrastus, who wrote about three hundred years before. Among the objects named by Pliny were, "*Bucardia*, like to an ox's heart;" "*Brontia*, resembling the head of a tortoise, supposed to fall in thunderstorms;" "*Glossoptra*, similar to a human tongue which does not grow in the earth, but falls from heaven while the moon is

[1] An Address, delivered before the American Association for the Advancement of Science, at Saratoga, N.Y., August 28, 1879, by Prof. O. C. Marsh, President.

[1] "Metamorphoses," Liber xv., 262.

eclipsed;" "the *Horn of Ammon*, possessing, with a golden colour, the figure of a ram's horn;" *Ceraunia* and *Ombria*, supposed to be thunderbolts; *Ostracites*, resembling the oyster shell; *Spongites*, having the form of sponge; *Phycites*, resembling sea-weed or rushes. He also mentions stones resembling the teeth of hippopotamus; and says that Theophrastus speaks of fossil ivory, both black and white, of bones born in the earth, and of stones bearing the figure of bones.

Tertullian (160 A.D.) mentions instances of the remains of sea animals on the mountains, far from the sea, but uses them as a proof of the general deluge recorded in Scripture.

During the next thirteen or fourteen centuries, fossil remains of animals and plants seem to have attracted so little attention, that few references are made to them by the writers of this period. During these ages of darkness, all departments of knowledge suffered alike, and feeble repetitions of ideas derived from the ancients seem to have been about the only contributions of that period to Natural Science.

Albert the Great (1205–1280 A.D.), the most learned man of his time, mentions that a branch of a tree was found, on which was a bird's nest containing birds, the whole being solid stone. He accounted for this strange phenomenon by the *vis formativa* of Aristotle, an occult force, which, according to the prevalent notions of the time, was capable of forming most of the extraordinary objects discovered in the earth.

Alexander *ab Alexandro*, of Naples, states that he saw, in the mountains of Calabria, a considerable distance from the sea, a variegated hard marble, in which many sea shells but little changed were heaped, forming one mass with the marble.

With the beginning of the sixteenth century, a great impetus was given to the investigation of organic fossils, especially in Italy, where this study really began. The discovery of fossil shells, which abound in this region, now attracted great attention, and a fierce discussion soon arose as to the true nature of these and other remains. The ideas of Aristotle in regard to spontaneous generation, and especially his view of the hidden forces of the earth, which he claimed had power to produce such remains, now for the first time were seriously questioned, although it was not till nearly two centuries later that these doctrines lost their dominant influence.

Leonardo da Vinci, the renowned painter and philosopher, who was born in 1452, strongly opposed the commonly accepted opinions as to the origin of organised fossils. He claimed that the fossil shells under discussion were what they seemed, and had once lived at the bottom of the sea. "You tell me," he says, "that Nature and the influence of the stars have formed these shells in the mountains; then show me a place in the mountains where the stars at the present day make shelly forms of different ages, and of different species in the same place." Again, he says, "In what manner can such a cause account for the petrifactions in the same place of various leaves, sea-weeds, and marine crabs?"

In 1517, excavations in the vicinity of Verona brought to light many curious petrifactions, which led to much speculation as to their nature and origin. Among the various authors who wrote on this subject was Fracastoro, who declared that the fossils once belonged to living animals, which had lived and multiplied where found. He ridiculed the prevailing ideas that the plastic force of the ancients could fashion stones into organic forms. Some writers claimed that these shells had been left by Noah's flood, but to this idea Fracastoro offered a mass of evidence which would now seem conclusive, but which then only aroused bitter hostility. That inundation, he said, was too transient; it consisted mainly of fresh water; and if it had transported shells to great distances, must have scattered them over the surface, not buried them in the interior of mountains.

Conrad Gesner (1516—1565), whose history of animals has been considered the basis of modern zoology, published at Zurich in 1565 a small but important work entitled "De rerum Fossilium, Lapidum, et Gemmarum figuris." It contained a catalogue of the collection of fossils made by John Kentmann. This is the oldest catalogue of fossils with which I am acquainted.

George Agricola (1494—1555) was, according to Cuvier, the first mineralogist who appeared after the revival of learning in Europe. In his great work, "De Re Metalica," published in 1546, he mentions various fossil remains, and says they were produced by a certain *materia pinguis*, or fatty matter, set in fermentation by heat. Some years later Bauhin published a descriptive catalogue of the fossils he had collected in the neighbourhood of Boll, in Würtemberg.[1]

Andrew Mattioli, a distinguished botanist, adopted Agricola's notion as to the origin of organized fossils, but admitted that shells and bones might be turned into stone by being permeated by a "lapidifying juice." Falloppio, the eminent professor of anatomy at Padua, believed that fossil shells were generated by fermentation where they were found; and that the tusks of elephants, dug up near Apulia, were merely earthy concretions. Mercati, in 1574, published figures of the fossil shells preserved in the Museum of the Vatican, but expressed the opinion that they were only stones, that owed their peculiar shapes to the heavenly bodies. Olivi, of Cremona, described the fossils in the Museum at Verona, and considered them all "sports of nature."

Palissy, a French author, in 1580, opposed these views, and is said to have been the first to assert in Paris that fossil shells and fishes had once belonged to marine animals. Fabio Colonna appears to have first pointed out that some of the fossil shells found in Italy were marine, and some terrestrial.

Another peculiar theory discussed in the sixteenth century deserves mention. This was the vegetation theory, especially advocated by Tournefort and Camerarius, both eminent as botanists. These writers believed that the seeds of minerals and fossils were diffused throughout the sea and the earth, and were developed into their peculiar forms by the regular increment of their particles, similar to the formation of crystals. "How could the *Cornu Ammonis*," Tournefort asked, "which is constantly in the figure of a volute, be formed without a seed containing the same structure in the small, as in the larger forms? Who moulded it so artfully, and where are the moulds?" The stalactites which formed in caverns in various parts of the world were also supposed to be proofs of this vegetative growth.

Still another theory has been held at various times, and is not yet entirely forgotten, namely: that the Creator made fossil animals and plants just as they are found in the rocks, in pursuance of a plan beyond our comprehension. This theory has never prevailed among those familiar with scientific facts, and hence needs here no further consideration.

An interest in fossil remains arose in England later than on the Continent; but when attention was directed to them, the first opinions as to their origin were not less fanciful and erroneous than those to which we have already referred. Dr. Plot, in his "Natural History of Oxfordshire," published in 1677, considered the origin of fossil shells and fishes to be due to a "plastic virtue, latent in the earth," as Theophrastus had suggested long before. Lhwyd, in his "Lithophylacii Britannici Ichnographia," published at Oxford in 1699, gives a catalogue of English fossils contained in the Ashmolean Museum. He opposed the *vis plastica* theory, and expressed the opinion that the spawn of fishes and other marine animals had been raised with the vapours from the sea, conveyed inland by clouds, and deposited by rain, had permeated into the interior of the earth, and thus produced the fossil remains we find in the rocks. About this time several important works were published in England by Dr. Martin Lister, which did much to infuse a true knowledge of fossil remains. He gave figures of recent shells side by side with some of the fossil forms, so that the resemblance became at once apparent. The fossil species of shells he called "turbinated and bivalve stones," and adds, "either these were terriginous, or if otherwise, the animals which they so exactly represent have become extinct."

During the seventeenth century there was a considerable advance in the study of fossil remains. The discussions in regard to the nature and origin of these objects had called attention to them, and many collections were now made, especially in Italy, and also in Germany, where a strong interest in this subject had been aroused. Catalogues of these collections were not unfrequently published, and some of them were illustrated with such accurate figures, that many of the species can now be readily recognized. In this century, too, an important step in advance was made by the collection and description of fossils from particular localities and regions, in distinction from general collections of curiosities.

Casper Schwenkfeld, in 1600, published a catalogue of the

[1] "Historia novi et admirabilis Fontis Balneique Bollensis, in Ducata Wirtembergico." Moulbeillard, 1598.

fossils discovered in Silesia; in 1622, a detailed description of the renowned Museum of Calceolarius, of Verona, appeared; and in 1642, a catalogue of Besler's collection; Warmius's catalogue was published in 1652; Spener's in 1663; and Septala's in 1666. A description of the Museum of the King of Denmark was issued in 1669; Cottorp's catalogue in 1674, and that of the renowned Kirscher in 1678. Dr. Grew gave an account in 1687 of the specimens in the Museum of Gresham's College in England; and in 1695, Petiver of London published a catalogue of his very extensive collection. A catalogue by Fred. Lauchmund, on the fossils of Hildesheim, appeared in 1669, and the fossils of Switzerland were described by John Jacob Wagner in 1689. Among similar works were the dissertations of Gyer at Frankfort, and Albertus at Leipsic.

Steno, a Dane, who had been professor of Anatomy at Padua, published, in 1669, one of the most important works of this period.[1] He entered earnestly into the controversy as to the origin of fossil remains, and by dissecting a shark from the Mediterranean, proved that its teeth were identical with some found fossil in Tuscany. He also compared the fossil shells found in Italy with existing species, and pointed out their resemblance. In the same work, Steno expressed some very important views in regard to the different kinds of strata, and their origin, and first placed on record the important fact that the oldest rocks contain no fossils.

Scilla, the Sicilian painter, published in 1670 a work on the fossils of Calabria, well illustrated. He is very severe against those who doubted the organic origin of fossils, but is inclined to consider them relics of the Mosaic deluge.

Another instance of the power of the *lusus naturæ* theory, even at the close of the seventeenth century, deserves mention. In the year 1696, the skeleton of a fossil elephant was dug up at Tonna, near Gotha, in Germany, and was described by William Ernest Tentzel, a teacher in the Gotha Gymnasium. He declared the bones to be the remains of an animal that had lived long before. The Medical Faculty in Gotha, however, considered the subject, and decided officially that this specimen was only a freak of nature.

Beside the authors I have mentioned, there were many others who wrote about fossil remains before the close of the seventeenth century, and took part in the general discussion as to their nature and origin. During the progress of this controversy the most fantastic theories were broached, and stoutly defended, and although refuted from time to time by a few clear-headed men, continually sprang up anew, in the same or modified forms. The influence of Aristotle's views of equivocal generation, and especially the scholastic tendency to disputation, so prevalent during the middle ages, had contributed largely to the retardation of progress, and yet a real advance in knowledge had been made. The long contest in regard to the nature of fossil remains was essentially over, for the more intelligent opinion at the time now acknowledged that these objects were not mere "sports of nature," but had once been endowed with life. At this point, therefore, the first period in the history of palæontology, as I have indicated it, may appropriately end.

It is true that later still, the old exploded errors about the plastic force and fermentation were from time to time revived, as they have been almost to the present day; but learned men, with few exceptions, no longer seriously questioned that fossils were real organisms, as the ancients had once believed. The many collections of fossils that had been brought together, and the illustrated works that had been published about them, were a foundation for greater progress, and, with the eighteenth century, the second period in the history of palæontology began.

The main characteristic of this period was the general belief that *fossil remains were deposited by the Mosaic deluge*. We have seen that this view had already been advanced, but it was not till the beginning of the eighteenth century that it became the prevailing view. This doctrine was strongly opposed by some courageous men, and the discussion on the subject soon became even more bitter than the previous one, as to the nature of fossils.

In this diluvial discussion theologians and laymen alike took part. For nearly a century the former had it all their own way, for the general public, then as now, believed what they were taught. Noah's flood was thought to have been universal, and was the only general catastrophe of which the people of that day had any knowledge or conception.

[1] "De Solido intra Solidum naturaliter Contento."

The scholars among them were of course familiar with the accounts of Deucalion and his ark, in a previous deluge, as we are to-day with similar traditions held by various races of men. The firm belief that the earth and all it contains was created in six days; that all life on the globe was destroyed by the deluge excepting alone what Noah saved; and that the earth and its inhabitants were to be destroyed by fire, was the foundation on which all knowledge of the earth was based. With such fixed opinions, the fossil remains of animals and plants were naturally regarded as relics left by the flood described in Holy Writ. The dominant nature of this belief is seen in nearly all the literature in regard to fossils published at this time, and some of the works which then appeared have become famous on this account.

In 1710, David Büttner published a volume entitled "Rudera Diluvii Testes." He strongly opposed Lhwyd's explanation of the origin of fossils, and referred these objects directly to the flood. The most renowned work, however, of this time, was published at Zurich, in 1726, by Scheuchzer, a physician and naturalist, and professor in the University of Altorf. It bore the title "Homo Diluvii Testis." The specimen upon which this work was based was found at Oeningen, and was regarded as the skeleton of a child destroyed by the deluge. The author recognised in this remarkable fossil, not merely the skeleton, but also portions of the muscles, the liver, and the brain. The same author was fortunate enough to discover, subsequently, near Altorf, two fossil vertebræ, which he at once referred to that "accursed race destroyed by the flood!" These, also, he carefully described and figured in his "Physica Sacra," published at Ulm in 1731. Engravings of both were subsequently given in the "Copper-Bible." Cuvier afterwards examined these interesting relics and pronounced the skeleton of the supposed child to be the remains of a gigantic salamander, and the two vertebræ to be those of an ichthyosaurus!

Another famous book appeared in Germany in the same year in which Scheuchzer's first volume was published. The author was John Bartholomew Adam Beringer, professor at the University of Würtzburg, and his great work[1] indirectly had an important influence upon the investigation of fossil remains. The history of the work is instructive, if only as an indication of the state of knowledge at that date. Prof. Beringer, in accordance with views of his time, had taught his pupils that fossil remains, or "figured stones," as they were called, were mere "sports of nature." Some of his fun-loving students reasoned among themselves, "if nature can make figured stones in sport, why can not we?" Accordingly, from the soft limestone in the neighbouring hills, they carved out figures of marvellous and fantastic forms, and buried them at the localities where the learned professor was accustomed to dig for his fossil treasures. His delight at the discovery of these strange forms encouraged further production, and taxed the ingenuity of these youthful imitators of Nature's secret processes. At last Beringer had a large and unique collection of forms, new to him, and to science, which he determined to publish to the world. After long and patient study, his work appeared, in Latin, dedicated to the reigning prince of the country, and illustrated with twenty-one folio plates. Soon after the book was published, the deception practised upon the credulous professor became known; and in place of the glory he expected from his great undertaking, he received only ridicule and disgrace. He at once endeavoured to repurchase and destroy the volumes already issued, and succeeded so far that few copies of the first edition remain. His small fortune, which had been seriously impaired in bringing out his grand work, was exhausted in the effort to regain what was already issued, as the price rapidly advanced in proportion as fewer copies remained; and, mortified at the failure of his life's work, he died in poverty. It is said that some of his family, dissatisfied with the misfortune brought upon them by this disgrace and the loss of their patrimony, used a remaining copy for the production of a second edition, which met with a large sale, sufficient to repair the previous loss, and restore the family fortune. This work of Beringer's, in the end, exerted an excellent influence upon the dawning science of fossil remains. Observers became more cautious in announcing supposed discoveries, and careful study of natural objects gradually replaced vague hypotheses.

The above works, however, are hardly fair examples of the literature on fossils during this part of the eighteenth century. Scheuchzer had previously published his well-known "Com-

[1] "Lithographia Wirceburgensis, ducentis lapidum figuratorum, a potiori, insectiformium, prodigiosis imaginibus exornata." Wirceburgi, 1726. Edit. II. Francofurti et Lipsiæ. 1767.

plaint and Vindication of the Fishes," illustrated with good plates. Moro, in his work on "Marine Bodies which are found in the Mountains," 1740, showed the effects of volcanic action in elevating strata, and causing faults. Vallisneri had studied with care the marine deposits of Italy. Donati, in 1750, had investigated the Adriatic, and ascertained by soundings that shells and corals were being imbedded in the deposits there, just as they were found in the rocks.

John Gesner's dissertation, "De Petrificatis," published at Leyden in 1758, was a valuable contribution to the science. He enumerated the various kinds of fossils, and the different conditions in which they are found petrified, and stated that some of them, like those at Oeningen, resembled the shells, fishes, and plants of the neighbouring region, while others, such as Ammonites and Belemnites, were either unknown species, or those found only in distant seas. He discusses the structure of the earth at length, and speculates as to the causes of changes in sea and land. He estimates that, at the observed rate of recession of the ocean, to allow the Apennines, whose summits are filled with marine shells, to reach their present height, would have taken about eighty thousand years, a period more than "ten times greater than the age of the universe." He accordingly refers the change to the direct command of the Deity, as related by Moses, that, "The waters should be gathered together in one place, and the dry land appear."

Voltaire (1694-1778) discussed geological questions and the nature of fossils in several of his works, but his published opinions are far from consistent. He ridiculed effectively and justly the cosmogonists of his day, and showed, also, that he knew the true nature of organic remains. Finding, however, that theologians used these objects to confirm the Scriptural account of the deluge, he changed his views, and accounted for fossil shells found in the Alps, by suggesting that they were Eastern species, dropped by the pilgrims on their return from the Holy Land!

Buffon, in 1749, published his important work on Natural History, and included in it his "Theory of the Earth," in which he discussed, with much ability, many points in geology. Soon after the book was published he received an official letter from the Faculty of Theology in Paris, stating that fourteen propositions in his works were reprehensible, and contrary to the creed of the Church. The first objectionable proposition was as follows: "The waters of the sea have produced the mountains and valleys of the land,—the waters of the heavens reducing all to a level, will at last deliver the whole land over to the sea, and the sea successively prevailing over the land, will leave dry new continents like those we inhabit."

Buffon was politely invited by the college to recant, and having no particular desire to be a martyr to science, submitted the following declaration, which he was required to publish in his next work: "I declare that I had no intention to contradict the text of Scripture; that I believe most firmly all therein related about the creation, both as to order of time and matter of fact; and I abandon everything in my book respecting the formation of the earth, and, generally, all which may be contrary to the narration of Moses."

This single instance will suffice to indicate one great obstacle to the advancement of science, even up to the middle of the eighteenth century.

Another important work appeared in France about this time, Bourguet's "Traité des Petrifactions," published in 1758, which is well illustrated with faithful plates. In England, a discourse on earthquakes, by Dr. Robert Hooke, was published in 1705. This author held some views in advance of his time, and maintained that figured stones were "really the several bodies they represent or the mouldings of them petrified, and not, as some have imagined, a *lusus naturæ*, sporting herself in the needless formation of useless things." He anticipates one important conclusion from fossils, when he states that "though it must be very difficult to read them and to raise a chronology out of them, and to state the intervals of time wherein such or such catastrophes and mutations have happened, yet it is not impossible." He also states that fossil turtles and such large Ammonites as are found in Portland, seem to have been the productions of hotter countries, and hence it is necessary to suppose that England once lay under the sea within the torrid zone. He seems to have suspected that some of the fossils of England belonged to extinct species, but thought possibly they might be found living in the bottom of distant oceans.

Dr. Woodward's "Natural History of the Fossils of England" appeared in 1729. This work was based on a systematic collection of fossils which he had brought together, and which he subsequently bequeathed to the University of Cambridge, where it is still preserved, with his arrangement carefully retained. The descriptive part of this work is interesting, but his conclusions are made to coincide strictly with the Scriptural account of the creation and deluge. He had previously stated, in another work, that he believed, "the whole terrestrial globe to have been taken to pieces and dissolved at the flood, and the strata to have settled down from this promiscuous mass." In support of this view, he stated that, "Marine bodies are lodged in the strata according to the order of their gravity, the heavier shells in stones, the lighter in chalk, and so of the rest."[1]

The most important work on fossils published in Germany at this time, was that of George Wolfgang Knorr, which was continued after his death by Walch. This work consisted of four folio volumes, with many plates, and was printed at Nuremberg, 1755-73. A large number of fossils were accurately figured and described, and the work is one of permanent value.[2] A French translation of this work appeared in 1767-78. Burton's "Oryctographie de Bruxelles," 1784, contains figures and descriptions of fossils found in Belgium.

Abraham Gottlieb Werner (1750–1817), Professor of Mineralogy at Freyberg, did much to advance the science of geology, and indirectly, that of fossils. He first indicated the relations of the main formations to each other, and, according to his pupil, Prof. Jameson, first made the highly important observation "that different formations can be discriminated by the petrifactions they contain." Moreover, "that the petrifactions contained in the oldest rocks are very different from any of the species of the present time; that the newer the formation, the more do the remains approach in form to the organic beings of the present creation." Unfortunately, Werner published little, and his doctrines were mainly disseminated by his enthusiastic pupils.

The great contest between the Vulcanists and the Neptunists started at this time, mainly through Werner, whose doctrines led to the controversy. The comparative merits of fire and water, as agencies in the formation of certain rocks, were discussed with a heat and acrimony characteristic of the subject and the time. Werner believed in the aqueous theory, while the igneous theory was especially advocated by Hutton of Edinburgh and his illustrator, Playfair. This discussion resulted in the advancement of descriptive geology, but the study of fossils gained little thereby.

The "Protogæa" of Leibnitz, the great mathematician, published in 1749, about thirty years after his death, was a work of much merit. This author supposed that the earth had gradually cooled from a state of igneous fusion, and was subsequently covered with water. The subsidence of the lower part of the earth; the deposits of sedimentary strata from inundations, and their induration, as well as other changes, followed. All this, he supposed to have been accomplished in a period of six natural days. In the same work Leibnitz shows that he had examined fossils with considerable care.

Linnæus (1707–1778), the famous Swedish botanist, and the founder of the modern system of nomenclature in Natural History, confined his attention almost entirely to the living forms. Although he was familiar with the literature of fossil remains, and had collected them himself, he did not include them in his system of plants and animals, but kept them separate, with the minerals; hence he did little directly to advance this branch of science.

During the last quarter of the eighteenth century, the belief that fossil remains were deposited by the deluge sensibly declined, and the dawn of a new era gradually appeared. Let us pause for a moment here and see what real progress had been made; what foundation had been laid on which to establish a science of fossil remains.

The true nature of these objects had now been clearly determined. They were the remains of animals and plants. Most of them certainly were not the relics of the Mosaic deluge, but had been deposited long before, part in fresh water and part in the sea. Some indicated a mild climate, and some the tropics. That any of these were extinct species, was as yet only suspected. Large collections of fossils had now been made, and valuable catalogues, well illustrated, had been pub-

[1] "Essay towards a Natural History of the Earth." 1695.

[2] "Lapides ex celeberr. viror. sententia diluvii universalis testes, quos in ordines ac species distribuit, suis caloribus expremit, etc." 272 Tab. 1755-73.

lished. Something was known, too, of the geological position of fossils. Steno, long before, had observed that the lowest rocks were without life. Lehmann had shown that above these primitive rocks, and derived from them, were the secondary strata, full of the records of life, and above these were alluvial deposits, which he referred to local floods and the deluge of Noah. Rouelle, Fuchsel, and Odoardi had shed new light on this subject. Werner had distinguished the transition rocks, containing fossil remains, between the primitive and the secondary, while everything above the chalk he grouped together as "The overflowed land." Werner, as we have seen, had done more than this, if we give him the credit his pupils claim for him. He had found that the formations he examined contained each its own peculiar fossils, and from the older to the newer there was a gradual approach to recent forms. William Smith had worked out the same thing in England, and should equally divide the honour of this important discovery.

The greatest advance, however, up to this time was that men now preferred to *observe* rather than to *believe*, and facts were held in greater esteem than vague speculations. With this preparation for future progress, the second period in the history of palæontology, as I have divided it, may appropriately be considered at an end.

Thus far I have said nothing in regard to one branch of my subject, the *methods* of palæontological research, for up to this time, of method there was none. We have seen that those of the ancients who noticed marine shells in the solid rock, called them such, and concluded that they had been left there by the sea. The discovery of fossils led directly to theories of how the earth was formed. Here the progress was slow. Subterranean spirits were supposed to guard faithfully the mysteries of the earth, while above the earth, Authority guarded with still greater power the secrets men in advance of their age sought to know. The dominant idea of the first sixteen centuries of the present era was, that the universe was made for Man. This was the great obstacle to the correct determination of the position of the earth in the universe, and later, of the age of the earth. The contest of astronomy against authority was long and severe, but the victory was at last with science. The contest of geology against the same power followed, and continued almost to our day. The result is still the same. In the early stages of this contest, there was no strife, for science was benumbed by the embrace of superstition and creed, and little could be done till that was cast off. In a superstitious age, when every natural event is referred to a supernatural cause, science cannot live; and often as the sacred fire may be kindled by courageous far-seeing souls, will it be quenched by the dense mist of ignorance around it. Scarcely less fatal to the growth of science is the age of Authority, as the past proves too well. With freedom of thought, came definite knowledge, and certain progress;—but two thousand years was long to wait.

With the opening of the present century, began a new era in Palæontology, which we may here distinguish as the third period in its history. This branch of knowledge became now a science. Method replaced disorder, and systematic study superseded casual observation. For the next half century the advance was continuous and rapid. One characteristic of this period was, *the accurate determination of fossils by comparison with living forms*. This will separate it from the two former epochs. Another distinctive feature of this period was the general belief that *every species, recent and extinct, was a separate creation*.

At the very beginning of the epoch we are now to consider, three names stand out in bold relief: Cuvier, Lamarck, and William Smith. To these men the science of palæontology owes its origin. Cuvier and Lamarck, in France, had all the power which great talent, education, and station could give; William Smith, an English surveyor, was without culture or influence. The last years of the eighteenth century had been spent by each of these men in preparation for his chosen work, and the results were now given to the world. Cuvier laid the foundation of the palæontology of Vertebrate animals; Lamarck, of the Invertebrates; and Smith established the principles of Stratigraphical Palæontology. The investigator of fossils to-day seldom needs to consult earlier authors of the science.

George Cuvier (1769-1832), the most famous naturalist of his time, was led to the study of extinct animals by ascertaining that the remains of fossil elephants he examined were extinct species. "This idea," he says later, "which I announced to the Institute in the month of January 1796, opened to me views entirely new respecting the theory of the earth, and determined me to devote myself to the long researches and to the assiduous labours which have now occupied me for twenty-five years."[1]

It is interesting to note here that in this first investigation of fossil vertebrates, Cuvier employed the same method that gave him such important results in his later researches. Remains of elephants had been known to Europe for centuries, and many authors, from Pliny down to the contemporaries of Cuvier, had written about them. Some had regarded the bones as those of human giants, and those who recognised what they were considered them remains of the elephants imported by Hannibal or the Romans. Cuvier, however, compared the fossils directly with the bones of existing elephants, and proved them to be distinct. The fact that these remains belonged to extinct species was of great importance. In the case of fossil shells, it was difficult to say that any particular form was not living in a distant ocean; but the two species of existing elephants, the Indian and the African, were well known, and there was hardly a possibility that another living one would be found.

It is important to bear in mind, too, that Cuvier's preparations for the study of the remains of animals was far in advance of any of his predecessors. He had devoted himself for years to careful dissections in the various classes of the animal kingdom, and was really the founder of comparative anatomy, as we now understand it. Cuvier investigated the different groups of the whole kingdom with care, and proposed a new classification founded on the plan of structure, which in its main features is the one in use to-day. The first volume of his Comparative Anatomy appeared in 1800, and the work was completed in five volumes in 1805.

Previous to Cuvier, the only general catalogue of animals was contained in Linnæus' "Systema Naturæ." In this work, as we have seen, fossil remains were placed with the minerals, not in their appropriate places among the animals and plants. Cuvier enriched the animal kingdom by the introduction of fossil forms among the living, bringing all together into one comprehensive system. His great work, "Le Règne Animal," appeared in four volumes in 1817, and with its two subsequent editions remains the foundation of modern zoology. Cuvier's classic work on vertebrate fossils—"Recherches sur les Ossemens Fossiles," in four volumes, appeared in 1812-13. Of this work, it is but just to say that it could only have been written by a man of genius, profound knowledge, the greatest industry, and with the most favourable opportunities.

The introduction to this work was the famous "Discourse on the Revolutions of the Surface of the Globe," which has perhaps been as widely read as any other scientific essay. The discovery of fossil bones in the gypsum quarries of Paris, by the workmen, who considered them human remains; the careful study of these relics by Cuvier, and his restorations from them of strange beasts that had lived long before, is a story with which you are all familiar. Cuvier was the first to prove that the earth had been inhabited by a succession of different series of animals, and he believed that those of each period were peculiar to the age in which they lived.

In looking over his work after a lapse of three-quarters of a century, we can now see that Cuvier was wrong on some important points, and failed to realise the direction in which science was rapidly tending. With all his knowledge of the earth, he could not free himself from tradition, and believed in the universality and power of the Mosaic deluge. Again, he refused to admit the evidence brought forward by his distinguished colleagues against the permanence of species, and used all his great influence to crush out the doctrine of evolution, then first proposed. Cuvier's definition of a species, the dominant one for half a century, was as follows: "A species comprehends all the individuals which descend from each other, or from a common parentage, and those which resemble them as much as they do each other."

The law of "Correlation of Structures," as laid down by Cuvier, has been more widely accepted than almost any thing else that bears his name; and yet, although founded in truth, and useful within certain limits, it would certainly lead to serious error if applied widely in the way he proposed.

In his discourse, he sums this law as follows: "A claw, a shoulder blade, a condyle, a leg or arm bone, or any other bone

[1] "Ossemens fossiles." Second Edition, vol. i. p. 178.

separately considered, enables us to discover the description of teeth to which they have belonged; so also reciprocally we may determine the form of the other bones from the teeth. Thus, commencing our investigation by a careful survey of any one bone by itself, a person who is sufficiently master of the laws of organic structure, may, as it were, reconstruct the whole animal to which that bone had belonged."

We know to-day that unknown extinct animals cannot be restored from a single tooth or claw, unless they are very similar to forms already known. Had Cuvier himself applied his methods to many forms from the early tertiary or older formations, he would have failed. If, for instance, he had had before him the disconnected fragments of an eocene tillodont, he would undoubtedly have referred a molar tooth to one of his pachyderms; an incisor tooth to a rodent; and a claw bone to a carnivore. The tooth of a hesperornis would have given him no possible hint of the rest of the skeleton, nor its swimming feet the slightest clue to the ostrich-like sternum or skull. And yet, the earnest belief in his own methods led Cuvier to some of his most important discoveries.

Jean Lamarck (1744-1829), the philosopher and naturalist, a colleague of Cuvier, was a learned botanist before he became a zoologist. His researches on the invertebrate fossils of the Paris Basin, although less striking, were not less important than those of Cuvier on the vertebrates; while the conclusions he derived from them form the basis of modern biology. Lamarck's method of investigation was the same, essentially, as that used by Cuvier, namely: a direct comparison of fossils with living forms. In this way, he soon ascertained that the fossil shells imbedded in the strata beneath Paris were, many of them, extinct species, and those of different strata differed from each other. His first memoir on this subject appeared in 1802,[1] and, with his later works, effected a revolution in conchology. His "System of Invertebrate Animals" appeared the year before, and his famous "Philosophie zoologique," in 1809. In these two works, Lamarck first announced the principles of evolution. In the first volume of his "Natural History of Invertebrate Animals,"[2] he gave his theory in detail; and to-day one can only read with astonishment his far-reaching anticipations of modern science. These views were strongly supported by Geoffroy Saint-Hilaire, but bitterly opposed by Cuvier; and their great contest on this subject is well known.

In looking back from this point of view, the philosophical breadth of Lamarck's conclusions, in comparison with those of Cuvier, is clearly evident. The invertebrates on which Lamarck worked offered less striking evidence of change than the various animals investigated by Cuvier; yet they lead Lamarck directly to evolution, while Cuvier ignored what was before him on this point, and rejected the proof offered by others. Both pursued the same methods, and had an abundance of material on which to work, yet the facts observed induced Cuvier to believe in catastrophes; and Lamarck, in the uniform course of nature. Cuvier declared species to be permanent; Lamarck, that they were descended from others. Both men stand in the first rank in science; but Lamarck was the prophetic genius, half a century in advance of his time.

(*To be continued.*)

FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE French Association for the Progress of Science has taken a bold step and decided that its session for 1881 will take place in Algiers. To avoid the numerous inconveniences of the strong heat which prevails all over Algeria in the month of August, it has been decided that the meeting should be held in April, during the Easter recess.

This happy result of the deliberations must be attributed to the personal exertions of M. Albert Grévy, the brother of the President of the French Republic, who holds the post of Civil Governor-General of Algeria.

It is supposed that the new scientific establishment whose formation has been decreed this year, will be formally inaugurated on this occasion, and a scientific movement of some importance will take place in the colony.

The *Akhbar* announced a few days back that a geographical society is being organised in Algiers.

[1] "Mémoire sur les Fossiles des Environs de Paris." 1802-6.

[2] "Histoire naturelle des Animaux sans Vertèbres." 7 vols. Paris, 1815-1822. Second Edition. 11 vols. 1835-1845.

In the meantime a number of representatives headed by Algerian senators and deputies will make a tour of exploration during the month of October. They will start at the end of September, as we announced some weeks ago. They will witness an agricultural and horticultural exhibition, which is to be held at Bone, for the whole of Algeria and Tunisia, and which will be held in Algiers in 1881.

The most successful lecture this year at Montpellier, was organised by the Languedocian Society of Geography. MM. Soleillet, Brau de Saint Pol Lias, Director of the Sumatra Exploring Company, and other explorers or intending explorers, appeared before the public on that occasion. M. Rabaut, the President of the Society of Geography of Marseilles, and the commercial agent for the Sultan of Zanzibar, gave most interesting details of the several explorations at present going on in that part of the Dark Continent.

The lecture on the progress of electricity was given by M. Denayrouze, of Jablochkoff candle notoriety. The speaker tried to show that Jamin's candle ought to be superior to the light which is spreading so largely in Paris and in London.

Another lecture was delivered by M. Barral, Perpetual Secretary of the National Society of Agriculture, on the necessity of using Rhone water for irrigation. There is, however, a variety of opinion on this subject, commercial people being really opposed to the irrigation scheme for the reason that it would diminish the quantity of water necessary for navigation, especially as it is intended to submerge vines in order to save them from phylloxera, the plague of the country.

A very interesting display took place in the Polygon, of the destroying power of modern methods of warfare, as practised by French engineers of the 2nd Regiment, which is garrisoned in Montpellier. It cannot be said that science is alien to the use of dynamite and electric sparks for such purposes, but it is the first time that warfare has been considered as being really within the limits of a scientific association.

Two of the most interesting excursions were devoted to agriculture—one to the experimental grounds established by M. Marey, one of the most active correspondents of the Academy of Sciences, with a view to destroy phylloxera, and the other to the School of Agriculture directed by M. Camille Saint Pierre. This school, established with the help of the General Council only a few years back, has already reached a high point of prosperity. Its reputation is so high in the Mediterranean regions that the Greek Government is sending there a number of pupils at its own expense.

The Sericicultural Station has been placed under the direction of M. Maillot, a pupil of M. Pasteur at the Normal School of Paris, who has already instructed ninety-two persons in the difficult art of observing silkworms' eggs with microscopes.

At the Viticultural Station American vines, insecticide, and all the proposed means of destroying phylloxera are being studied.

All the pupils of the Normal School for public teachers, are attending a course of lectures in that establishment, so that the teachers of the young Herault peasants will have a scientific knowledge of new methods proposed for scientific agriculture of the region.

SCIENTIFIC SERIALS

American Journal of Science and Arts, August.—This number opens with the first portion of a paper by Mr. Upham, on terminal moraines of the North American ice-sheet.—Prof. Kimball describes experiments with regard to the effects of magnetisation on the tenacity of iron and on the flexure of a soft iron bar. *Inter alia*, he proves that a soft iron bar has its tenacity increased about nine-tenths of 1 per cent. by magnetising it to saturation.—Prof. Hilgard calls attention to some points in connection with the loess of the Mississippi valley, which seems to render the Æolian hypothesis untenable regarding that and similar deposits elsewhere; the hypothesis, viz., that the true loess is always a subaërial deposit, formed in a dry central region, and that it owes its structure to the formative influence of a steppe vegetation.—Dr. Cutter describes his method of micro-photography with Tolles's $\frac{1}{75}$-inch objective.—Prof. Peirce demonstrates the value of M. Faye's proposal of a method of swinging pendulums for the determination of gravity, and Mr. Hodges offers some considerations on the size of molecules, arising out of the conversion of water into steam, and the combining effect of platinum on hydrogen and oxygen.—Among other topics treated are the geology of Virginia, the discovery of a new group of carboni-

ferous rocks in South-Eastern Ohio, and the Laramie group of Southern Colorado and Northern New Mexico.

Journal of the Franklin Institute, August.—The following may here be noted:—Committee Report on the Fairbank's testing machine.—A new method of constructing index plates for gear cutters, by Prof. Sweet.—A new genus in telephones, by Prof. Dolbear.—On the use of determining slag densities in smelting, by Mr. MacFarlane.

Bulletin de l'Académie Royale des Sciences (*de Belgique*), No. 6, 1879.—Besides the paper of M. Montigny on the colour in scintillation of stars (elsewhere noticed), we note here an account of a new method, by M. Bruylants, for preparing hydriodic and hydrobromic acids, viz., adding iodine and bromine to the terpene contained abundantly in balsam of copaiba, and then detaching them under the influence of heat in the state of the corresponding acids.—The physiology of the muscles and nerves of the lobster is elucidated by MM. Fredericq and Vandevelde, who show that the only difference from superior animals is in the velocity of the nervous influence, this being, in the lobster, only 6 metres per second. Further, it is diminished considerably in the termination of the motor-nerves.—Mr. Macleod communicates a histological paper on the Harder gland in the domestic duck; and M. Schleicher writes on the living cartilaginous cell, the protoplasm of which he finds to consist of two different substances, one nearly liquid and homogeneous, the other, solid elements endowed with contractility (the nucleus is similarly formed).—M. Dubois describes some new birds.

No. 7.—M. Montigny here brings forward evidence that the principal star γ of Andromedes is subject to changes of colour, which are very probably periodic.—M. Plateau finds, in two notes by Brewster, confirmation of his views on the nature of irradiation.—A paper by MM. Masquelin and Swaen treats of the first phases of development of the maternal placenta in the rabbit, and M. Folie writes on some theorems relative to surfaces of superior order.

Journal de Physique, August.—On the temperature of the polar extremities of carbons producing the electric light, by M. Rossetti.—On Ampère's formula, by M. Jamin.—Researches on the compressibility of gases, by M. Cailletet.—M. Faber's speaking machine, by M. Gariel.

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. xii. fasc. xiv.—On the problem of subdivision of the electric light, by Prof. Ferrini.—Observations of Swift's comet at the Observatory of Brera, by Prof. Schiaparelli.—Study on some crania of Araucanians and Pampas in the National Museum of Anthropology of Florence, by Dr. Riccardi.—Results of observations on the diurnal period of magnetic declination during 1872-77, at the observatory of Brera in Milan, by Dr. Rajna.—On the Mascart electrometer, by Dr. Maggi and S. Ascoli.—Experiments on the capillarity of water, by Dr. Poloni.

Fasc. xv.—On the transformation of the 11th order of elliptic functions, by S. Klein.—On special corpuscles (psorosperms) of man, by Dr. Grassi.—On the application of the dynamometer in operations of lithotrity, by Prof. Scarenzio.—Meteorological observations at the Observatory of Brera, in Milan, in 1878, by S. Frisiani.—Contributions to a study of the lias fauna of Lombardy, by Dr. Parona.

THE *Jahrbuch der k.k. geologischen Reichsanstalt* (Vienna, ii., April to June) contains an elaborate treatise by C. M. Paul and Dr. E. Tietze, entitled "New Studies on the Sandstone-zone of the Carpathian Mountains." The remainder of the part is taken up by a petrographical study on the granite of Predazzo, by A. Sigmund, followed by some geological and petrographical notes on the older eruptive and stratified rocks of the Middle and Eastern Alps, by Dr. Guido Stache and Conrad von John. The latter paper is the second communication these gentlemen have made on the subject, and treats specially of the Cevedale district as the distribution district of older dioritic porphyrites. It is accompanied by four well-drawn plates.—The *Abhandlungen* of the same Society (vol. xii. Heft 1) contain the first part of an excellent treatise by R. Hoernes and M. Auinger on the Gasteropoda of the marine deposits of the first and second miocene Mediterranean stages in the Austro-Hungarian Empire. The species here described belong all to the genus *Conus*, and are well reproduced on six magnificent plates. Thus we have illustrations of Chelyconus, Rhizoconus, Lithoconus, Dendroconus, Liptoconus, and Stephanoconus, representing some fifty-two different varieties.

SOCIETIES AND ACADEMIES

LONDON

Entomological Society, September 3.—J. Jenner Weir, F.L.S., F.Z.S., treasurer, in the chair.—Mr. Philip B. Mason exhibited specimens of *Harpalus oblongiusculus*, Dej., taken at Portland, and also, on behalf of Mr. Gameys, specimens of *Euplectus ambiguus*, Reich., found in flood refuse at Repton.—Miss E. A. Ormerod read "Notes on the Prevention of Cane-borers."—Mr. Jenner Weir exhibited a pair, male and female, of *Cicada montana*, Scop., taken at the New Forest, Hampshire.—M. Ch. Oberthur communicated the following paper: "Observations sur les Lépidoptères des Îles Sangir et Descriptions de quelques Espèces nouvelles."

PARIS

Academy of Sciences, September 8.—M. Daubrée in the chair.—The following papers were read:—On the mean value of numerical coefficients in a skew determinant of order infinitely great, by Prof. Sylvester.—Pathological predisposition and immunity; influence of origin or of race on the aptitude of animals of ovine species to contract splenic disease, by M. Chauveau. Algerian sheep seem to enjoy immunity from this disorder. M. Chauveau selected nine from different lots of authentic origin in the Lyons market (to which large numbers are imported). Notwithstanding repeated inoculation (three and five times), none of them showed multiplication of the *Bacillus anthracis*, characteristic of the disease. On the other hand, French sheep and rabbits all succumbed after the first inoculation. M. Chauveau urges the importance of this question of special immunity.—The President expressed the lively satisfaction of the Academy at M. Nordenskjöld's return.—On the causes of reinvasion of phylloxerised vines, by M. de Laffitte.—On the same subject, by M. Cauvy.—On the compounds of hydracids with ammonia, by M. Maumené. Some observations on the *rôle* of insects during the flowering of *Arum crinitum*, Ait., by M. Schnetzler. Of the flies attracted by the fetid odour of this Arum, those most pressed to lay, deposit their eggs at the bottom of the spathe; then, prevented escaping by the viscous hairs at the entrance, they die. Others, less pressed to lay, are attracted by the glandular hairs on the spadix, which lead them, like the degrees of a scale, to the stamens. There, walking on the anthers, they liberate the pollen, and remounting the spadix in the direction of the hairs, they fly off to lay their eggs in another spathe, at the bottom of which they deposit on the stigmata the pollen brought from the stamens of another individual; then, imprisoned in their turn, they die. The purple red hairs covering a good deal of the interior surface of the spathe probably contain an acid which, like that exuding from the hairs of Drosera, may contribute to transformation of the azotised matters of insects into matters absorbable by the spathe.

GÖTTINGEN

Royal Academy of Sciences, May 3.—On sums of the greatest wholes in arithmetical series, by Herr Zeller.—On the galvanic resistance of gas-carbon, by Herr Auerbach.

June 4.—New relations between the class numbers of the quadratic form of negative determinants, by Herr Gierster.

June 14.—On endogenous formation of normal lateral shoots in the genera Rytiphlœa, Vidalia, and Amansia, by Herr Falkenberg.

CONTENTS

THURSDAY, SEPTEMBER 25, 1879

THE AGRICULTURAL ANTS OF TEXAS

The Natural History of the Agricultural Ant of Texas: a Monograph of the Habits, Architecture, and Structure of "Pogonomyrmex barbatus." By Henry Christopher McCook. Author's Edition. Academy of Natural Sciences of Philadelphia. 1879. (London: Trübner and Co.)

THE agricultural ant of Texas was first introduced to the English public in 1862, by means of a communication from Dr. Gideon Lincecum to Mr. Darwin, published in the *Journal* of the Linnean Society of London, and much interest was excited by the account given of an insect which actually sowed seed, tended the crop, and reaped the harvest. No further information being forthcoming, doubts were expressed both here and in America as to the accuracy of the observations, and Mr. McCook went to Texas in the summer of 1877 for the express purpose of testing them. Unfortunately, however, he could only stay about three weeks, which he devoted entirely to observation of the ants. He however obtained information from residents, and carried away some living ants on which to make further observations at home, and the result is given in much detail in a handsome volume of over 200 pages, illustrated by a series of twenty-four plates, giving details of the nests, the attitudes, the habits, the external structure and internal anatomy of the species in question, and some of its allies.

With all this elaboration, however, the main point still remains in doubt, and Mr. McCook does not and cannot tell us whether the agricultural ants really do sow the seed, though they undoubtedly reap the harvest. What he does tell us, however, is sufficiently curious. The insect is a true harvesting-ant, like those so well described by Mr. Moggridge, but it differs from all other species in forming large cleared disks on the site of its nests. These disks vary from two to twelve or fourteen feet in diameter, and are approximately circular, and however thick may be the grassy or weedy vegetation around them the disks are perfectly bare and smooth and thus form very conspicuous objects in the landscape. The openings to the nests and granaries are near the centre of the disk, and in some cases are formed in a central convex or conical mound, while in others the surface is entirely flat. In about one-third of the nests examined by Mr. McCook, the outer border of the disk, sometimes for two feet wide, was covered by a crop of ant-rice (*Aristida oligantha*) differing wholly in appearance and colour from the surrounding vegetation, just as a crop of wheat or oats differs from a field of mixed herbage, while not a solitary weed of any kind was to be found in the belt of ant-rice.

Lincecum had stated that the seeds of the ant-rice were regularly sowed in the autumn, kept weeded during winter and spring, and reaped in summer. Mr. McCook was only able to see the last stage. The plant had certainly been weeded; its seeds were found in the granaries mixed with many others; and, it is admitted "that there is nothing unreasonable, or beyond the probable capacity of the emmet intellect, in the supposition that the crop is actually sown. Simply it is the Scotch verdict—not proven." This is very unsatisfactory, and as the journey appears to have been undertaken for the express purpose of testing this, the only incredible part of Lincecum's observations, it seems curious that it should have been made in July, at the time of the harvest, instead of in November, the time of the alleged sowing of the crop. If we reject the "sowing" as too improbable, the only other explanation of the facts seems to be that the *Aristida* is one of those singular plants which constantly appear on cleared ground although not growing in the immediate vicinity, and that the ant's clearings prepare the conditions for its growth. A few experiments would soon test this, and it is a great pity some resident could not be found to determine this most interesting point either by observation or experiment. The book is, however, full of valuable matter as to the habits and actions and the whole domestic economy of ants; and there is a useful chapter on "the ancient belief in harvesting ants—how it was discredited and how restored," in which the opinions of many ancient and modern authors are given with a number of suggestive extracts from the classics as well as from the Rabbinical laws and traditions. We cannot, however, but feel some regret that the author did not make more extended observations before writing so voluminous a work, so that he might have been able to clear up the numerous points now left in uncertainty. The chief authority for a number of important statements is still Dr. Lincecum, who appears to have resided for many years in Texas and to have assiduously studied the habits of the ants, and there does not seem to be any essential point in which Mr. McCook's own observations show his predecessor to have been in error. On the contrary he must be considered to have proved the substantial accuracy of the doctor's facts so far as he was able to do so in the limited time at his command.

ALFRED R. WALLACE

EXPERIMENTAL GEOLOGY

Études Synthétiques de Géologie Expérimentale. Par A. Daubrée, Membre de l'Institut, Directeur de l'École Nationale des Mines, &c. (Paris: Dunod.)

MONSIEUR DAUBRÉE has, during the last thirty years, published numerous very important memoirs describing the production, upon a small scale in the laboratory, of various natural geological phenomena. These papers, which were originally scattered through the pages of different scientific journals, are now for the first time brought together. The first part of this work, under the title of "Application of Experimental Methods to the Study of Various Geological Phenomena," forms a handsome and well-illustrated volume of nearly five hundred pages. This is to be followed by a second part, to be entitled "Application of Experimental Methods to Various Cosmological Phenomena," which will describe investigations recently made on the constitution and characteristics of meteorites.

The earlier portion of the volume before us details the results of numerous experiments made with the object of explaining different geological phenomena, of which some are chemical and physical, while others are simply mechanical.

To the first class belong the history of mineral deposits, of crystalline rocks, both eruptive and metamorphic, and of the different forces producing vulcanicity.

Among the phenomena belonging to the second category are the formation of pebbles, sand, and clay, as well as sundry other effects of trituration and transport. The distortions and ruptures of the earth's crust, such as the production of faults and joint-systems, also belong to this division, which includes the origin of the schistosity and cleavage of rocks, the distortion of fossils, and certain peculiarities in the structure of mountain chains. Lastly, the author treats of the temperature developed in rocks by mechanical action.

Among the more striking and instructive experiments for which science is indebted to M. Daubrée, are those in which glass tubes partially filled with water are incased in tubes of iron, also containing water, and subjected for lengthened periods to a high temperature at a pressure of above one thousand atmospheres. By this treatment not only was the glass decomposed, but crystalline quartz presenting all the characteristics of natural crystals of that mineral was produced. Crystals of pyroxene were obtained by the same means, and fragments of wood similarly treated were converted into anthracite.

The formation of various crystallised zeolitic and other minerals, such as chabazite, christianite, and calcite, in the masonry of the Roman baths at Plombières and the deposit of mammellar opal by their waters, teach the importance of time as a factor in such transformations. In this case the different minerals, instead of being rapidly produced at a high temperature have been slowly developed at a low heat and without appreciable increase of pressure. Numerous coloured illustrations are given as seen under the microscope, of thin sections of Roman bricks inclosing zeolites in their cavities, and attention is directed to the fact that in one instance at least the structure of the mass has been rendered distinctly fluidal by pressure applied to the clay in making the original brick.

The production of numerous well-crystallised metallic minerals by the action of the waters of Bourbonne-les-Bains upon a quantity of Roman bronze coins and on some ancient lead piping, which had been for centuries subjected to its action, is an equally curious and instructive fact. These waters issue from the earth at a temperature of 58° C., and contain soluble matter to the extent of from seven to eight grammes per litre. This consists of alkaline chlorides, bromides and sulphates, chlorides and sulphates of calcium and magnesium, alkaline silicates, and traces of arsenic and manganese. In addition to these substances various others are present in subordinate quantities.

Among the well-crystallised minerals resulting from the action of water upon the metals and alloys present, cuprite, redruthite, chalcopyrite, tetrahedrite, phosgenite, anglesite, galena, and iron pyrites were recognised and examined.

The investigations bearing upon the history of volcanic phenomena, which demonstrate that an infiltration of water can take place through a porous medium in spite of a high steam-pressure operating in a contrary direction, are both valuable and suggestive, and the experiments on such mechanical questions as the causes of the contortion of strata and of the faults and jointings in rocks, throw much new light upon those obscure questions.

In its complete form M. Daubrée's treatise will represent the life-work of a trained and careful investigator in an almost untrodden direction, and will form the first text-book on experimental geology. The portion now published cannot fail to be read by geologists with great interest and profit, and we trust the time is not far distant when experimental geology will have become a generally recognised branch of geological investigation.

J. A. P.

OUR BOOK SHELF

Annual Record of Science and Industry for 1878. Edited by Spencer F. Baird, with the assistance of eminent men of science. (New York: Harper Brothers; London: Trübner, 1879.)

It again becomes our pleasant duty to call the attention of our readers to the excellent annual record of science edited by Mr. Baird, Secretary of the Smithsonian Institution. We think the editor has done wisely in discontinuing the division of the record into two parts, for hitherto the summary of progress has been followed by abstracts of papers. At present the second part has been merged into the first, so that summary of progress in the various branches of science now includes a large amount of detail; each summary being prepared by some recognised authority in the United States. As we have had occasion to remark before, the division on the physics of the globe, prepared by Mr. Cleveland Abbé, with the assistance of Prof. Rockwood, is, in our judgment, the most important contribution to the volume. The compilation and classification of the facts presented in this summary must have been a work of great labour, and the thanks of all physicists and meteorologists are due to Mr. Abbé for having so admirably carried out the task he has undertaken.

The summary of physics and chemistry seems to us somewhat incomplete; there is no reference, for example, to the new forms of stereoscope invented by Mr. Grubb, nor to the remarkable memoirs published by Mr. Johnstone Stoney during the past year in the *Transactions* of the Royal Dublin Society; in fact, the omission of all mention of the active work done by this flourishing society is a serious oversight of the editor.

The value of the summary of physics and chemistry would also be much enhanced if, instead of abruptly beginning each paragraph with the name of the investigator, the nature of the investigation were put first, and a reference given in each case to the publication where fuller details could be found We trust that this last—a most important point, which is carried out in some of the reports, will next year be extended to all.

Greater editorial care seems also required in bringing about a more uniform system of classification throughout the volume, and the omission of repetition—take for example Prof. Jevons' paper on Pedesis, which is twice described in detail on pp. 216 and 376. Why, too, amongst British journals of pure and applied science are the *Quarterly Journal of Science*, the *Telegraphic Journal*, the *Electrician*, and *Engineering* omitted, whilst *Iron* is included?

We make these remarks in no captious spirit, but with the real desire to augment the usefulness of this work. For the same reason we would urge the paramount importance of having, in addition, an English and a Continental editor. It is impossible for a work of this kind to be otherwise thoroughly done, nor can a proper appreciation (often lacking in the volume before us) be shown, of the relative merit of the investigations scattered over the

numerous scientific journals of to-day. We look forward to the time when the *Annual Record of Science* will become a standard work absolutely indispensable to all libraries, both public and private, at home and abroad.

W. F. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Heat of the Comstock Mine

I NOTICE in NATURE, vol. xx. p. 168, that Dr. Lesley quotes from Prof. Barker an opinion in regard to the heat of the Comstock Mines in Nevada. Referring to my assertion that the heat of the rock "is pretty uniform" in the lower levels, Prof. Barker announces that there are "the most remarkable differences, some of the higher levels being much hotter than some of the lower levels." This is perfectly true, and the fact is no disproof of my assertion. In the article to which Dr. Lesley refers (*Silliman's Journal*, April, 1879) I said that there are striking differences of temperature in the rock, and endeavoured to explain them by showing that there is a great mass of rock which may be regarded as heated to a tolerably uniform degree at all points in the length of the lode, on any given level, and that in this general mass there are isolated localities, most of which show a temperature above that of the rock at large, but some of them below it. I pointed out the conditions under which these local maxima occur, and gave the explanation to which I thought they led. The hot spots are evidently narrow and long, and as the mine openings sometimes intersect and sometimes follow them for some distance, a given level will be for a part of its length in a hot belt and for a part in the general mass of heated rock, or one level may be in a hot belt and show a much higher temperature than the level below, which entirely escapes the exceptionally hot ground. In this way thermometric variations are obtained between different levels and between different parts of the same levels, and these facts were all brought out in my article.

I should not trouble you with this explanation did I not feel that the Comstock lode bids fair to become a classic field for the discussion of terrestrial temperatures. Mr. Clarence King is now on the ground, and will, no doubt, make its unrivalled heat phenomena the subject of careful examination, and everything that bears upon the question has importance.

Dr. Lesley expresses some doubt upon the mechanical theory of earth-heat which was one of Prof. Barker's two conclusions upon the source of the heat. The Comstock is certainly good ground to test this question, for I have never witnessed such constant and general movement of the rocks in any other mines. Still, I do not share Prof. Barker's opinion on this, or on his other point, "that the heat is a hot-water heat." No mining engineer would pronounce the Comstock a wet lode. It discharges four and a half million tons of water yearly, and yet out of the more than twelve miles of linear excavation made every year, I do not believe that 1,000 feet are in ordinarily wet ground. It is a dry lode for the greater part, and in writing upon the subject my efforts have been directed to seeking an explanation for the extraordinary temperature of this dry rock.

JOHN A. CHURCH

115, Broadway, New York, September 8

Crossley's Modification of Hughes's Microphone

EVER since Hughes's discovery of those principles which led to his invention of the microphone, inventors have been trying to improve the instrument by adopting every variety of form and employing every combination of apparatus that were likely to lead to good results. The failures must have been legion, and of the successes the members of the British Association have had during their stay at Sheffield, an opportunity of examining and seeing at work perhaps the most efficient—Crossley's modification of the microphone. Six distant places—the two newspaper offices and four meeting-rooms—were telegraphically connected with the Cutlers' Hall, where a switch-board stood to place any two distant stations into communication, thus illustrat-

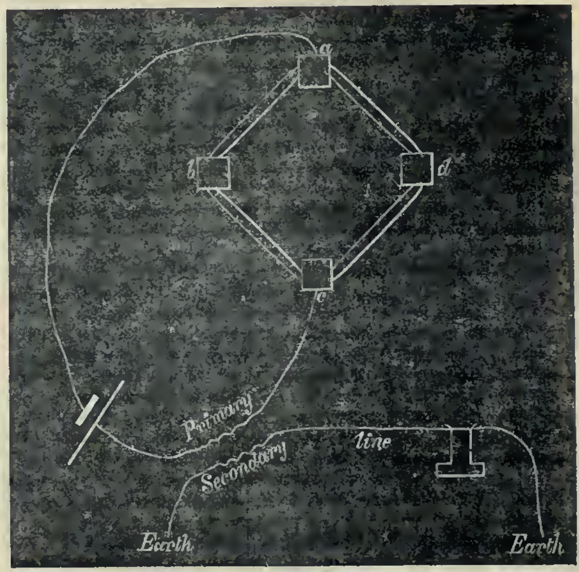


FIG. 1.

ing the exchange system so largely employed in America. Every one is aware that with the telephone the speaker has to hold the

FIG. 2.

instrument to his mouth; with the Crossley's transmitter, however, conversation, a few feet away, is readily conveyed. The transmitter is now being largely employed in the United King-

dom, and it is found that where telephones alone are useless because of the induction of adjacent wires, the instrument acts admirably. The undulatory current produced by sonorous vibrations is so intense that a person speaking about a foot away from a transmitter has been heard ten feet from an ordinary telephone in Manchester thirty-six miles away by wire, and this although the induction from some thirty adjacent wires had to be overcome, and we may add that the intensity of the sound may be largely augmented by employing increased battery power.

Four carbon pencils are nicely centred and loosely held in four blocks of carbon, *a b c d;* two opposite blocks, *a* and *c*, are connected in circuit with a battery and the primary wire of an induction-coil. The efficiency of the arrangement is now made complete by having a telephone in the secondary circuit. The carbon blocks are mounted on a thin wooden diaphragm, and consequently are not seen in Fig. 3, which represents one form of the finished instrument.

For some months past an interesting and highly successful operation has been made every Sunday. One of these trans-

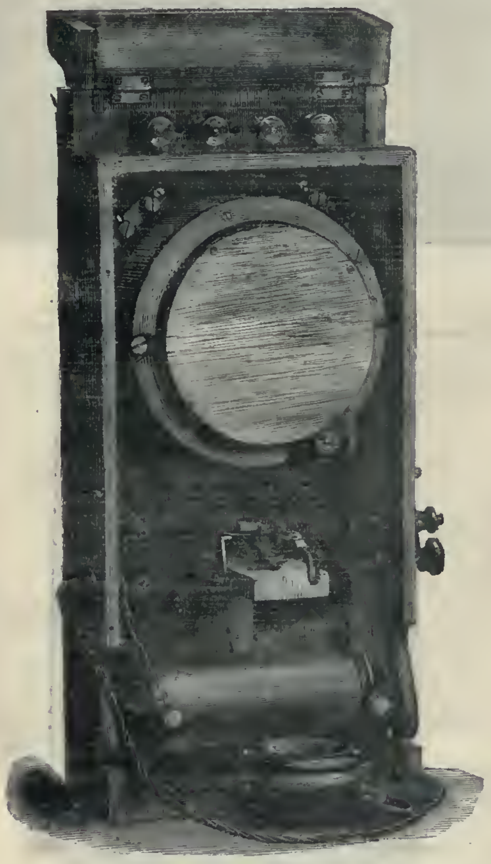


Fig. 3.

mitters is fixed in the pulpit of one of the Halifax places of worship. Its position is not over-favourable, being half hidden so as to escape attention, and thus to some extent its efficiency is interfered with. In the nether regions, where the organ-blowing apparatus is found, a Clamond's thermo-electric pile is placed, and one of the first duties of the sexton on a Sunday morning and evening is to light a gas jet under the pile. In this way a sufficient supply of electricity is obtained to work exceedingly well at a cost of less than 2*d.* per Sunday in gas consumed. On the outskirts of the town several houses have telephones in the secondary circuit, one of these belonging to an invalided lady, and the service, from the opening voluntary to the parting benediction, is heard plainly by every one. The rendering of the music is especially fine, sounding to the observer, sat at ease in an arm-chair, as if proceeding from a neighbouring room with the door slightly ajar.

William Ackroyd

Colour-Blindness

When your able reviewer Prof. Pole so plainly intimates, in Nature, vol. xx, pp. 477 to 480, that he does not consider any of the theories of colour-blindness he has mentioned to be altogether sufficient for the observed facts, and that he may return to the subject in a future number, I trust he may then take some notice of my views, as honoured by the Royal Society, Edinburgh, in vol. xxviii. of their *Transactions*.

At all events, it is much to be hoped that in his own future descriptions, he will define his colours more accurately than by the naked eye estimations and names of even those who are allowed to possess normal vision. For, as I have shown in the paper above alluded to, there are physical distinctions, amounting to more than the oppositions of black and white, and reacting on colour, between many pigments generally reputed by the world to be all of the same colour to the eye.

To speak therefore of green, or red, or brown is nothing; but it is what green, and what red, and what brown that must be settled, as a preliminary to any further safe observation on the subject.

Piazzi Smyth

15, Royal Terrace, Edinburgh, September 19

The Carving of Valleys

In the course of a recent visit to Loch Maree, I observed an interesting geological phenomenon in a glen on the east side of the loch, which is traversed in ascending Ben Slioch, from Kinlochewe, and which is called, I understand, Glen Beansdale. This glen, in its lower part at least, follows the line of division between the "fundamental gneiss," which rises in a gradual slope on the north side, and the "Cambrian sandstone," which on the south side forms a fine cliff, terminating at the base in a long steep "*débris* line." The stream, which is of considerable size, originally ran close to the foot of this cliff until it reached the wide valley which contains the loch; but at some period a large "bergfall" of rocks from the sandstone cliff has dammed up the original bed, and diverted the stream into a new course, diagonally across the gentle slopes of gneiss, which previously formed the north side of the glen. This new course is marked, first, by a small depression or gully in the flow of the glen, and secondly, in the middle of this, by a narrow ravine with vertical sides, just wide enough to contain the stream which foams at the bottom.

There is nothing in itself very remarkable about this diversion of a stream; but the point which gives the case its interest is that an inferior limit can be fixed for the time at which the diversion took place. For, on descending into the secondary depression above mentioned, I was able to trace the glaciation, or planing down by ice of the edges of the gneiss (which was admirably clear on these slopes) right down to the brink of the little ravine containing the stream, thus showing conclusively that the diversion had taken place *before* the glacial period, and so long before that the stream had time to cut a channel sufficient to guide the glacier in its flow, and divert it from the work it would otherwise have accomplished in clearing away the remains of the berg-fall, and re-opening the old river-course. Thus it will be seen that in the new channel we have an example of the work which can be done by a mountain stream during a period dating back at least beyond the glacial epoch; while the old channel exemplifies the work done in the same time by the various agencies of "sub-aërial waste"—rain, wind, frost, &c.—without a stream to assist them, either by direct erosion of its own or by sweeping away the *débris* which they had brought down.

What, then, are the phenomena presented by these two cases? In the first, the only work which can really be ascribed to the stream is the cutting of the deep narrow gorge at the bottom of which it now runs; for with regard to the wider depression above (itself a mere furrow in the main flow of the glen), it is impossible to say how much has been due to the planing action of the ice. In the second, the bottom of the old channel, if there be any power in "sub-aërial waste," should be choked by the *débris* which has come down from its sides, whereas I was easily able to detect live rock within a few feet of the tiny runnel which now drains the gully, and which itself picks its way among stones and boulders that are clearly nothing but the cumbered bed of the old-world torrent.

The question I wish to ask is whether the study of these two examples is not sufficient to produce something like a conviction that the modern school of geologists (as worthily represented by

the President-Elect of the British Association) is after all in error, and that the true agency which has carved out our valleys and given us our mountain scenery is still to seek. The evidence of the new channel agrees with that to be found elsewhere (on its grandest scale in the cañons of North America), in showing that the action of streams is to excavate not open valleys, but narrow and vertical clefts. On the other hand, the agencies of "sub-aërial waste" are seen to have worked their will for untold ages on the Cambrian sandstone of Glen Beansdale, and to have produced—nothing. They have not even removed the blocks of the old berg-fall, which looked as if they might have fallen within the memory of man, instead of at a date which must be reckoned by thousands, if not millions, of years. There remains the power of ice, which I am by no means disposed to undervalue; but the traces of the last "glacial period" are in this case clear enough, and amount at most to a slight deepening of the lower part of the glen, while to assume previous and much more intense glacial action, of which no direct evidence remains, would scarcely be justifiable. WALTER R. BROWNE

A "Nightly Resurrection"

YESTERDAY, in the *Pall Mall Budget* of July 11, 1879, p. 22, in a review of Mr. Stevenson's—"Travels with a Donkey in the Cevennes," I read the following, which is an extract of Mr. Stevenson's book. It is a very interesting observation. He slept a good deal under trees at night, and he says: "And there is one stirring hour unknown to those who dwell in houses, when a wakeful influence goes abroad, and all the out-door world (meaning animals and men who sleep in the open) are on their feet. It is then that the cock first crows. . . . Cattle awake in the meadows, sheep break their fast on dewy hill-sides, and change to a new lair among the ferns; and houseless men, who have lain down with the fowls, open their dim eyes and behold the beauty of the night. . . . Even shepherds and old country folk, who are the deepest read in these arcana, have not a guess as to the means or purpose of this nightly resurrection. Towards two in the morning they declare the thing takes place, and neither know nor inquire further."

This is a very curious and interesting fact, but Mr. Stevenson is mistaken when he states that this "stirring hour," "when a wakeful influence goes abroad," between the hours of *one and two in the morning*, is unknown to those who dwell in houses. I have been aware of it for a long time, and have noticed it year after year on myself, although I dwell in a house. In the winter I usually go to sleep at 9 P.M., and then feel cold and require a good deal of bed covering to keep me warm; but between one and two in the morning I feel uncomfortable, wake, and feel hot, and am obliged to throw off some of the bed-clothes. Afterwards this discomfort passes away, I pull over me the blankets again, and go to sleep till daylight. This occurs morning after morning as regularly as possible.

In the summer I awake as regularly as possible about the same hour, and feel uneasy and toss about for some little time, although at this season no blankets are used, and then go to sleep again.

Since I have been at Fyzabad I have been able to test more accurately the hour in which this wakeful influence begins to occur. I used to awake at the usual hour, and while awake I invariably heard the railway whistle of the train which leaves for Lucknow at 12.50 A.M. Latterly I have not been noticing this whistle, and I am not aware that I wake at that hour, but there has been and is plenty of rain during this rainy season, saturating the soil and atmosphere with moisture. Probably this moisture may prevent that subtle "wakeful influence" from reaching the nervous system. Again, I am rather subject to an occasional neuralgic pain on the left side of my forehead. When this occurs at night, it goes on increasing to its *maximum* between one and two o'clock in the morning, and afterwards it begins to subside. I often suspected that some change in the *terrestrial magnetism* some time after the passage of the sun across the meridian, on the other side of the earth, may be the cause of this "subtle influence." Perhaps those who take observations on terrestrial magnetism may throw some light on this subject. Whatever may be this "subtle influence" which acts on the nervous system of animals between *one and two o'clock* A.M., there is a similar influence in the *day*, between one and two P.M., although it may not have been noticed. I have observed it, because when I get the before-named neuralgic pain in *the day*, it goes on increasing till between one and two o'clock P.M., when it begins to subside. This question arises: are the periodical exacerbations in fever and neuralgias, &c., due to some similar cosmical influence? Statistics on these points are worth collecting. It is natural to suppose that the nervous system of animals—a most sensitive tissue—would be readily influenced by any magnetic change of the earth, or by other subtle cosmical influences. E. BONAVIA

Fyzabad, August 19

A Habit of Cattle

MR. H. C. DONOVAN, in a letter headed as above (NATURE, vol. xx. p. 457), describes the bone munching of cattle in Natal, and asks whether they have a similar habit in other places. Such is the case in Norway, especially at the upper pasturages around the "saeters," or mountain chalets, where they are commonly supplied with a daily modicum of fish-bones and salt, which they eat with great avidity. There is but little lime on the Norwegian fjelds, the prevailing rock is mica schist.

Stonebridge Park, Willesden, September 17

W. MATTIEU WILLIAMS

Intellect in Brutes

LAST year we spent our holiday at Llan Bedr, Merionethshire. Our host has a house in the above village and another at Harlech, a town three miles distant. His favourite dog, Nero, is of Norwegian birth, and a highly intelligent animal. He is at liberty to pass his time at either of the houses owned by his master, and he occasionally walks from one to the other. More frequently, however, he goes to the railway station at Llan Bedr, gets into the train, and jumps out again at Harlech. Being, most probably, unable to get out of the carriage, he was on one occasion taken to Talsarnau, the station beyond Harlech, where he left the carriage, and waited on the platform for the return train to Harlech. If Nero did not make use of "abstract reasoning" we may as well give up the use of the term.

Manchester, September 20 WILLIAM HORSFALL

BERNHARD VON COTTA

ON the 14th inst. at Freiberg, in Saxony, this distinguished geologist breathed his last. Science has lost in him an ardent and conscientious follower, one in whom great powers of observation and reflection were harmoniously associated. He possessed in especial that "combining understanding" which Alexander von Humboldt so highly prized.

The youngest of four sons of the late Oberforstrath v. Cotta, of Tharand, in Saxony—a man celebrated as forester and founder of the Forstacademie in that picturesque little town not far from Dresden—Bernhard was born, October 24, 1808. His father had taken a great interest in natural sciences, and had much occupied himself with palæontology; and Bernhard appears to have inherited this taste. Early in life he was a student at the Freiberg Mining Academy—where he subsequently became Professor of Geology—and he likewise studied at Heidelberg and received a degree as Doctor of Philosophy. His intellectual activity soon became strongly pronounced and led, from the attainment of manhood till near the close of his life, to the publication of numerous valuable works. Whilst still a student at Freiburg, his first work, "Die Dendrolithen," was written (published 1832). Subsequently, associated with Prof. Naumann, he worked at the geological map of Saxony, which was published in twelve sections, and he afterwards alone completed a similar work for Thuringia. In 1836 appeared the first part of a work entitled "Geognostische Wanderungen," and in 1838 a second part; in these the principal geological features of the kingdom of Saxony are described and explained. He likewise wrote other works of great practical value, of which "Gangstudien," "Lehre von der Erzlagerstätten," and "Gesteinslehre" deserve most favourable mention. Of more theoretical value is a work which has gone through many and enlarged editions: "Anleitung zum Studium der Geognosie und Geo-

logie," the first edition of which appeared in 1839. Other works of like character by the same prolific author are: "Ueber den innern Bau der Gebirge" (1851), and "Geologische Fragen" (1858). In these works Bernhard von Cotta has shown himself to belong to the school of Lyell in so far as he holds unlimited time to be necessary for the explanation of geological processes.

The way in which natural sciences generally, and geology in especial, were grasped in Cotta's large and practical mind caused him earnestly to desire that geology should be more generally known and appreciated by men of average education, and he consequently published several works which, in the best sense, may be called popular. To these belong his "Letters on von Humboldt's Cosmos" (2 vols., 1851–52), "Geological Letters from the Alps" (1850), "Geological Pictures" (1852), "Catechism of Geology" (3rd edit., 1877), and last, not least, deserving mention, is his great work: "Geologie der Gegenwart" (the present state of geology), the 1st edition of which appeared in 1866, the 5th, partly re-written and enlarged, in 1878. These works have greatly contributed to put an end to those fantastical ideas about geology which so long prevailed, even amongst well-educated classes; and by promoting a sound understanding of geological states and processes, and of their bearing on practical life, they have done much to raise natural sciences in general estimation. Cotta's work, "Deutschlands Boden," must also here be named. Not only does it contain information of great importance to agriculturists, miners, and manufacturers, but statesmen, politicians, and sociologists may benefit much from studying it. It makes it plain that geology forms the basis of geography, that the outward forms we see on the surface of the earth have for the most part been inwardly conditioned. A German critic has called this work "Epochemachend," and viewed it as a first attempt to show clearly by particular instances "the influence of geological formations on the life of man."

Cotta's "Geologie der Gegenwart" merits more notice than I can here bestow upon it. It contains fifteen chapters or separate essays on that science and important subjects therewith connected. Two of these essays: "On Geology and History," and "The Development Law of the Earth," have been published by me in English. In this work the author has shown himself to be an evolutionist and a thorough adherent of Darwin's theory of the origin of species. He was one of the first—if not the first—eminent geologist who fully accepted this theory and applied it to the organic remains in sedimentary rocks. And that which in Germany has been called "Cotta's development law" is admirable and fascinating by its simplicity.

More than once has Prof. v. Cotta been in this country. On his first visit (1836)—when he made the acquaintance of Lyell—I had the pleasure of accompanying him from Germany. He has also travelled in France, Northern Italy, Tyrol, Switzerland, Hungary, the Banet, Transylvania, and the Carpathians, and has written many articles in various periodicals on his geological observations, &c., in those lands. The number of his monographs and fugitive essays would fill a good-sized volume. Many of his earliest excursions were undertaken in the company of his friend, the celebrated geologist, Leopold von Buch; Cotta likewise enjoyed the friendship of Alexander v. Humboldt, with whom he often corresponded. In 1868 he was invited by the Russian Government to visit the Altai Mountains to report on their geological formation, minerals, &c. On his return to Freiberg he wrote an account of his journey and observations, and in 1871 published a large volume "Der Altai: sein geologischer Bau und seine Erzlagerstätten."

All the writings of Cotta are remarkable for lucidity, terseness, and logical reasoning. In all the desire is apparent to discover by the inductive method that connection of things which—even when most difficult or impossible to perceive—we know must of necessity exist. Owing to this tendency of his mind he has been said to belong to the School of Positivists. Many of Cotta's works have been translated into other languages. His "Gesteinslehre" Mr. P. H. Lawrence has admirably given in English: "Rocks Classified and Described," &c. Numerous German and foreign academies and learned societies have bestowed upon him honorary membership, and foreign potentates have given him decorations. As long ago as 1867 von Cotta became a Foreign Correspondent of the Geological Society of London, and within the last few months the highest honour in the gift of that Society was conferred upon him by his election as Foreign Member.

In private life, as in his scientific pursuits, Bernard v. Cotta was characterised by truthfulness and directness of purpose, whilst to these qualities were added warmth and fidelity in his attachments, and also kind consideration for the feelings and wants of his fellows in general. Thus his memory will live not only in the love and esteem of a widow and three daughters, but will likewise be cherished by those who have enjoyed his friendship. I may add that Cotta, like nearly all men of genius, was absolutely free from pedantry; that he was sympathetic and readily interested in politics, general literature, and social life. He possessed, too, a strong sense of wit and humour, and could greatly enjoy a good joke. R. R. NOEL

A ZOOLOGICAL STATION AT SYDNEY

SEVERAL references to the scheme for the foundation of a zoological station at Sydney having appeared in NATURE since the idea was first mooted by Dr. Miclucho Maclay, it may be of interest to our readers to learn how far the project has progressed in the meantime.

A correspondent in Sydney informs us that the Government of New South Wales have granted an allotment of land for the purpose at Watson's Bay, a small watering-place about six miles from Sydney (with which there is communication by steamer several times daily), and close to the entrance of Port Jackson. The site is an excellent one for the purpose, having a frontage of about 125 feet to Port Jackson, with good dredging-ground within a stone's throw, and so near the open Pacific (though entirely sheltered) that pelagic organisms may be obtained abundantly with the tow-net without going many hundred yards. The New South Wales Government have also promised the sum of 300*l.* towards the expense of erecting the building, which sum will be placed in the hands of the trustees when an equal amount has been raised by private subscription. The 300*l.* must be subscribed within a year, failing which the conditional promise of Government assistance will be withdrawn. As yet the subscription list does not show a total of one-third of the required sum; a circular soliciting subscriptions has therefore been issued to such in Sydney and elsewhere as are likely to take an interest in the matter. The money having been obtained, it is intended to proceed with the building on the plan proposed by Dr. Maclay. According to this plan the building will consist of two stories, the lower occupied, in addition to a small sitting-room or vestibule, by several (most probably four) well-lighted work-rooms, with dissecting- and microscope-tables, aquaria, and other necessary fittings. Each laboratory will be for the accommodation of a single worker, and will communicate by a separate stairway with a bed-room on the upper storey. Those working in the station will, by this arrangement, be able to live quite independently of one another, and to work without disturbance or interruption. In the upper storey there will also be a large common room or library communicating by a stair with the vestibule. A photographic room will be built in the rear, and a boat-

house with boat, dredges, and other collecting gear will be added. The whole will be so arranged that additional accommodation may be added when found desirable.

We need not point out the importance of the station proposed to be erected in Sydney. It is expected that most of those who will make use of the station will come from England, and therefore it will be only fair that English biologists should help our Sydney friends to complete the 300*l.* required for the station. There is some fear that they may not be able to raise the whole sum in the colony, and we would therefore strongly urge upon those of our readers interested in the enterprise to lend a helping hand. Dr. J. C. Cox, Hunter Street, Sydney, acts as treasurer, and Mr. George Leslie, assistant to Sir Wyville Thomson, University, Edinburgh, has been asked to become treasurer for any subscriptions that may be raised at home.

Baron Maclay, we may state, is at present engaged in an excursion in Polynesia, and will return to Sydney about the end of the present year.

THE RESIGNATION OF DR. ANDREWS

WE learn with great regret that Dr. Andrews has resigned the post he has so long held as vice-president of Queen's College, Belfast, and Professor of Chemistry. Dr. Andrews had been urged by his brother professors to allow himself to be proposed for the first vacancy in the presidency of the College, but his sense of duty urged him to give a peremptory refusal.

With reference to Dr. Andrews's work both as a professor and as a scientific worker, we quote from an excellent article in the *Northern Whig* of the 18th inst.:—

"Before the formation of the Queen's University he had been Professor of Chemistry in the medical school of the Belfast Institution, and from this post he was transferred to a similar chair in Queen's College, while at the same time he was appointed its first vice-president. The importance of this latter office may be gathered from the fact that to a joint board, consisting of the presidents and vice-presidents of Belfast, Cork, and Galway, was remitted the arduous task of framing statutes and ordinances for the internal management of the colleges, and on this board there was certainly no stronger man than Dr. Andrews. The Queen's Colleges were launched upon the country as a great educational experiment. Founded upon the principle of united secular and separate religious instruction, they had to contend all through their career against opposition of the bitterest and most unscrupulous character. The men, therefore, who actually worked the vessel through its early dangers have deserved well of their country in no small degree, and in the front rank of these stands Dr. Andrews. And not merely was he a practical worker in the cause of united education; he has besides given to the world some of the most effective expositions of its principles. His address on the subject, delivered in 1867 to the Social Science Congress in Belfast, is one of the classics of the question, and it is not too much to say that its influence was powerfully felt in moulding opinion in England in preparation for the Liberal educational policy of 1870. Nor was he a less well-recognised authority in regard to the general question of university education. His little work entitled 'Studium Generale,' elicited, if we mistake not, by the supplemental charter proposals, contains a most fresh and vigorous enunciation of the most enlightened views upon higher education. As a teacher of science, Dr. Andrews has been most successful. His mastery of the subject found expression in exposition of the clearest and most lucid character, while his faculty of popular experimenting was of the most delicately accurate and attractive character. He had a peculiar power of gathering about him the *élite* of the best men of the year; wherever there was a man endowed with somewhat of the true scientific spirit, he was sure to gravitate towards the laboratory; and it is an interesting fact that the great majority of Dr. Andrews's most trusted laboratory students have turned out successful men in after life.

"But, however eminent have been Dr. Andrews's services in the directions already alluded to, it is as an original scientific investigator that he has gained his principal title to an immortal place in the annals of fame. Dr. Andrews belongs to the first rank of that remarkable body of professed chemists whose researches have been more of a physical than of a chemical nature. The names of Faraday, Graham, and Regnault, at once suggest themselves in this connection; and we are quite justified in saying that in insight, accuracy, and originality, as well as in the intrinsic value of their results, Dr. Andrews's investigations will bear comparison with the very best work of these great men. We cannot here attempt to give more than a very brief notice of the results of some of the more important of Dr. Andrews's papers. The complete list will be found in that invaluable work "The Royal Society Catalogue of Scientific Papers," to which all men of science are under the deepest obligations. The most important of his earlier investigations is a brilliant series of determinations of the heat of combination of different classes of substances. Considering the difficulties of this inquiry, as shown by the preposterous results which have sometimes been given even by able experimenters, the simplicity of Dr. Andrews's methods and the recognised accuracy of his results form a striking tribute to his care and skill. The results are not only of high theoretical value as regards the constitution of matter, but also of great importance for practical determinations of the electromotive force of various voltaic combinations. Next we have his grand researches on ozone, a remarkable body first distinctly recognised by Schönbein, whose nature was long a puzzle to chemists. It was reserved for Dr. Andrews to show (1) that ozone, from whatever source derived, is one and the same body; (2) that it is an allotropic form of oxygen. Before he cleared up these points it was generally supposed by chemists that there were different kinds of ozone, and that one of them, prepared by electrolysis, was a teroxide of hydrogen. In a second research Dr. Andrews traced the volumetric changes which occur in the formation of ozone from pure oxygen by the electric discharge—where it has been long known under the name of 'the smell of lightning'—and gave a number of similar and very remarkable volumetric changes observed in other gases, simple as well as compound, produced under the same experimental conditions. He showed that the chemical activity of chlorine could be greatly increased, just as that of oxogen was, by electric discharges. This question has again only very recently been reopened by a Continental chemist, who maintains that chlorine is not an element, but a compound body. The most recent of Dr. Andrews's grand contributions to science is his classical research into the 'Continuity of the Liquid and Gaseous States of Matter.' By means of a very simple but exquisite apparatus (prepared for him under his own directions by our very skilful townsman, Mr. Cumine), he showed that it was possible to convert a gas such as carbonic acid into a liquid, or the liquid into the gas, *without any discontinuity whatever*. In fact, a spectator may watch the body throughout the process, assure himself that it is gas at starting, and that it is liquid at last, and yet not be able to state *when* the change took place. From the scientific point of view, this phenomenon is best described by the use of Dr. Andrews's discovery of the 'critical point,' as it is called. For every gas or vapour there is a special temperature called its critical point, which is such that *only when the temperature of the gas or vapour is under that point can it exist in presence of the liquid;* so that the portion liquefied can be distinguished from the

rest. By these experiments Dr. Andrews cleared up the whole question of the liquefaction of gases by the separate or combined actions of cold and pressure. It is not too much to say that all the essential particulars as to apparatus and mode of working, by which two years ago the liquefaction of oxygen, and even of hydrogen, was effected simultaneously in France and in Switzerland, are to be found in Dr. Andrews's papers. It is to be regretted that the state of his health did not enable him to reap for himself (as he unquestionably would have done) this striking result of his beautiful investigations. But, after all, he has the credit of Adams or Leverrier, he pointed out how and where, with *certainty*, to find the hitherto unknown; and his glory is none the less that a Challis and a Galle, better provided with the requisite instrumental means, actually obtained the result. The mere fact of the liquefaction of oxygen, or the solidification of hydrogen, though very important in itself, is only one legitimate and inevitable consequence of Dr. Andrews's previous results; but it is vastly more easy of apprehension by the general public. But in the eye of science the demonstration that it is possible for matter to be made to pass by continuous stages from the gaseous to the liquid conditions forms one of the very greatest discoveries of even the nineteenth century.

"Such is the man whom, for the last half-century, we have had unostentatiously dwelling among us, prosecuting the labours that are only possible to the most exalted intellects of our race. Now that he goes into comparative retirement, there will be surely some means adopted of recognising in a permanent form connected with the college what it owes to him and to his great reputation."

GEOGRAPHICAL NOTES

WE learn from Oran that the French officers of the Staff in Algeria perceived for the first time on September 9 the electric light from the Spanish station of Tetica, at a distance of 272 kilometres. Commandant Perrier, director of the Algerian Survey, was enabled to measure one angle of the triangle, and the other having been measured from the Algerian station on the mountains, the operation may be considered as having been quite completed, and the junction of the Algerian network with the European triangulation an accomplished fact.

AT the meeting of the International Geodetical Association at Geneva no delegates are reported as having been sent from Sweden, Norway, Denmark, Netherlands, England, or Turkey. France, who resisted during the lifetime of Leverrier, sent MM. Charles Sainte Claire-Deville, Faye, and Yvon Villarceau. Not only was Germany represented by Professors Peters and Rhumkers, but Saxony by M. Bruhns, and Bavaria by M. Baurnfeind. Spain sent General Ibanez, Belgium Col. Adams, Russia General Forsch, Austria Prof. Oppolzer, Italy General Mayo, Prof. Respighi, Col. Ferrera, and Major Maggia; Switzerland had two representatives, Professors Hirsch and Plantamour, the head of the Geneva Observatory. The session was inaugurated by reading the report by M. Deville on experiments made by himself and M. Mascart, the director of the Central Bureau of French Meteorology, for the construction of the irido-platinum international metre.

M. TYAGHIN, an officer of the Russian Navy, who went in July of last year to Novaya Zemlya with his wife, a child, and three servants to winter at the life-station organised on the island, has just returned to Archangelse. All are well, and the little family has been increased by a new-born child. The winter was not severe, the greatest cold having been only $-29°\cdot1$ Celsius; and on August 1, when M. Tyaghin left Novaya Zemlya, the thermometer rose as high as 16°. The five Samoyede families who were sent to the same station are well, but one old man of more than sixty years and two others died from scurvy, and M. Tyaghin explains their death by the circumstance that they never went out of their dwelling and did not follow his recommendations. The hunting was good throughout the winter.

THE Russian Ministries of War and of Public Communications had resolved to send this year no less than three expeditions for the exploration of the old bed of the Amu-darya, and for researches as to the possibility of a water-communication between this river and the Caspian. The troubles in the Turcoman steppes hindered the starting of two of the expeditions which were to explore the steppes between Khiva and Krasnovodsk, and their departure has been postponed until January next. The third expedition has already started, and it is now engaged in the exploration of the Amu Darya River, and of its delta.

M. SIBIRYAKOFF publishes in Russian papers a telegram which he has received from Capt. Glasö, who tried this summer to enter the Kara Sea, and sail to the mouth of the Yenisei, on board the steamer *Samuel Owen*. All three passages, the Matochkin, the Kara, and the Yugor Straits, were encumbered with ice, and Capt. Glasö returned on August 26 without attempting the passage around the northern extremity of Novaya Zemlya.

ON July 28 last Dr. Gerhard Rohlfs' expedition left the Oasis of Batifal, situated at some twenty-eight kilometres distance from Djalo, in order to reach the northernmost Oasis of Siren in seven days, and Istat, the principal place in the southern Oasis of Kebalo, in the Kafra Group in twelve days. Dr. Rohlfs expected to arrive at Wadai in the middle of October. This results from a letter written by his companion, Dr. Stecker, to Prof. von Hochstetter, of Vienna. Another letter, written to a friend at Prague, states that Dr. Rohlfs will leave the expedition either at Wadai or even at Kafra, and return to Europe. Dr. Stecker will then continue the journey alone. It will be remembered that Dr. Rohlfs had already resolved to resign the leadership, but on second thoughts decided to remain. His final resignation is much to be regretted.

THE Imperial Geographical Society of St. Petersburg intends to form a connection with other institutions of the Russian Empire with a view of editing, in conjunction with them, a general description of Siberia with maps and plans, upon the occasion of the approaching tercentenary of the occupation of Siberia by the Russians. The Society will undertake the purely geographical part of the work and will also publish a bibliographical review of all other works on Siberia hitherto published.

THE International Society for the exploration of Equatorial Africa is very busy opening commercial relations between the settlements at the mouth of the Congo River and the interior. A few weeks ago the steamer *Barga* left Antwerp with European merchandise for this purpose. The steamer also takes out three small steam launches, a small steamer which will hold about thirty passengers, and three large goods-barges. By means of these the lower cataracts and rapids of the Congo will doubtless soon be reached. It is intended to establish stores at that point on both banks of the river. The question then will be to make a road along the river up to that point, where it again becomes navigable.

THE Imperial "Leopoldinisch-Carolinische" German Academy of Naturalists at Halle, which possesses the right of conferring doctor-diplomas, has lately bestowed this honourable distinction upon the three eminent travellers, Julius Payer, Karl Weyprecht, and Henry M. Stanley.

THE Berlin Geographical Society will celebrate the centenary of the birth of Karl Ritter, which happened on August 7, 1779, after the vacation, *i.e.* in October next.

TAILS[1]

WHAT are tails? The question seems an almost trivial one in its simplicity. Dictionaries tell us that the word "tail" denotes certain parts of animals, and also the hindermost or lowermost portion of anything. We speak habitually of the "tail of a coat," the "tail end of a crowd," the "tail of a kite," and of "pig-tails," as well as "tails of pigs." Evidently all these appellations are in use from the perception of more or less close analogies between the various things thus spoken of and certain things which every one who speaks English must call a tail—something which is unmistakably, truly, and properly a tail.

Such a thing, for example, is the tail of a cat or of a dog.

Let us, then, examine such an object and see what a typical tail is, and afterwards compare therewith other structures more or less closely or remotely resembling it.

But in order to understand that part of a cat which is called its "tail," we must understand those other parts which are not its tail, since we can never know any one thing whatever except by knowing other things from which such one thing is distinguished. We could not know "white," if everything that we saw was always of that colour.

The frame of a cat consists of a head, a trunk, limbs, and a tail.

Let us first look at its trunk. It consists of a solid fleshy wall (partly strengthened by bones—the ribs, breastbone and backbone) containing a cavity within; this cavity within the trunk is called the body-cavity. Inside this body-cavity are a variety of parts (*viscera*), such as the heart and its great blood-vessels, the liver, &c., and the cavity is traversed by a long, much-coiled tube called the alimentary canal, *i.e.*, swallow, stomach, intestines, &c.). Passing along the upper or dorsal side of the body is the backbone just mentioned. This consists of a complex chain of neatly articulated bones, each of which is called a *vertebra*, and the whole series of such bones form the *vertebral column*, *spine*, or *spinal column*, which are other names for the backbone. Now observe: Each vertebra of the trunk is in the form of an irregular ring. Therefore, as these rings come naturally in a series one behind the other, they together form a canal. This canal is called the *neural canal*, because it contains the central part of the nervous system, or *neural axis*, also *improperly* called the *spinal marrow*.

Thus, altogether, the cat's trunk consists of a solid case containing a body-cavity (within which lie the viscera), while the dorsal region of the case is traversed by the backbone or vertebral column, forming a canal along which runs the spinal marrow.

The neck is but the anterior prolongation of the trunk.

The cat's head is much more bony in proportion than is the trunk, and consists partly of a solid box, which holds the brain and shelters the ears and eyes and partly of a face and jaws, which latter bound the mouth. The brain case has a large hole behind, which matches with those which exist in each trunk vertebra, and through this hole the neural canal is continued on into the hollow of the skull, which is its expanded front end. Thus, altogether, the cat's head is in certain respects like its trunk. It is traversed by the alimentary tube, which opens at the mouth, and it has its dorsal part formed by the much-expanded neural canal (the skull-cavity) which contains the brain, or much-expanded anterior end of the neural axis.

The cat's limbs are very different in structure from the head and trunk. No body-cavity is contained in them, nor does the body-cavity of the trunk extend into any limb, nor again is any limb traversed by any part of the alimentary canal. Each limb has a solid bony support within it, but this support (the skeleton of each limb) is no part of the vertebral column, nor is it composed of any sort of vertebræ, but consists of a definite number of longer or shorter bones which are related to the support of the body or to its progression in walking, running, jumping, &c. These limb-bones do not contain any canal (as the backbone does), nor do they shelter any continuation sideways from the central part of the nervous system.

We now come to the tail, and if we examine it, we shall see that, to a certain extent, it partakes of the natures both of the trunk and of the limbs. It is like the limbs in that it is solid, that it contains no body-cavity, and is not traversed by the alimentary canal.

It is like the trunk in that it contains a prolongation of the vertebral column, and of the neural canal. In the head, we saw that the neural canal expanded, it receives its anterior enlarged termination—*the brain*. In the tail the neural canal contracts, and soon ceases, as it incloses the progressively diminishing posterior end of the neural axis—the termination backwards of the spinal marrow.

Let us examine the bones which form the cat's tail a little closely. They are about a score in number. The first seven or eight are all in the form of rings of bone, but behind these the vertebræ become merely more or less elongated solid bony cylinders, which get gradually smaller till they become mere rudiments of vertebræ. Beneath the vertebræ run blood-vessels, and on all sides are muscles which serve to bend the tail in all directions.

Such is the structure of the tail in this animal, *its use* (or "*function*") is not very important. Cats can live very well without their tails, and the well-known Isle of Man variety—the Manx cat—has scarcely more visible tail than we have ourselves. Yet the cat's tail no doubt aids to a certain extent in maintaining the balance of the body in the animal's various motions, and especially perhaps in climbing. Everybody has noticed the lateral undulations of the end of the tail of a cat which is watching a mouse, and it is curious to note how the wagging of the tail in the cat and the dog respectively, accompany very different emotions.

The gesture language of these two animals as expressed by the motion of their tails, and, indeed, by various other motions, is exceedingly different.

The structural characters which have been noticed concerning the cat's tail are substantially similar in all other beasts. In all, the tail is formed by a prolongation of the back bone (with more or less of neural canal), but has no body-cavity, and is not traversed by the alimentary canal.

But, although the essential structure in all beasts is similar, there are certain subordinate differences which merit our attention in the form of the tail in different beasts.

Dogs and cats belong to a great group of flesh-eating beasts, called, from their predominant mode of feeding, "*carnivora.*" Bears, weasels, badgers, civet-cats, seals, and sea-bears, also belong to this group.

If you enter the small mammalia house you may see a beast allied to the badger and weasel, called the *kinkajou.* This animal is an inhabitant of Brazil, and its tail bears a relation to the region it inhabits.

The animal lives in trees which it roams over in search of small animals on which it preys, such as birds' eggs and bees' nests, and these nests its sharp strong claws can tear, while it has an extremely long tongue, capable of being thrust into the cells and extracting the honey. But its tail, which is very long, is specially modified to assist it in its mode of life. The end of the tail is curled round, and is capable of strongly grasping any object about which it may be twined.

This kind of tail is called a "*prehensile tail,*" and acts as a fifth grasping organ, in addition to the two hands and the two feet.

It is in this prehensile character that the kinkajou's

[1] A Davis lecture recently delivered at the Zoological Gardens by Prof. St. George Mivart, F.R.S., V.P.Z.S.

tail, as I said, bears a relation to the region it inhabits. For Brazil consists mainly of an enormously extended forest, South America presenting us with the main forest region of the world. Consequently, the animals inhabiting this region must be fitted for an exceptionally arboreal life. The primeval forest exhibits as it were a world borne aloft upon enormous pillars.

Walking in such a forest, one wanders in obscurity amongst enormous lofty trunks, at the summits of which is a mass of entangled foliage high over head, and shutting out almost completely the sun's rays from below. It is in this upper world that most of the forest animals live, and such conditions necessitate in them special modifications of structure, of one kind or another, and the prehensile character of the kinkajou's tail is one such modification. I do not mean to say that animals with prehensile tails are not found elsewhere; we shall shortly see that they are. Neither do I mean to say that this particular character is universal amongst forest-living beasts of South America. The sloths, for example, are notoriously and exclusively forest-dwellers, and they are most exceptionally modified to suit their dwelling-place; but the mode of modification by which they are suited to a forest home is of quite another kind; it is one, however, which it would be beside our purpose to enter upon to-day. Nevertheless, this particular character of tail does crop up amongst South American beasts remarkably. Thus, for example, let us consider the great order of monkeys. Monkeys are scattered over almost all the warmest parts of the earth save the West Indies, Madagascar, New Guinea, and Australia. A great variety of species are found in Africa, India, and the Indian Archipelago, and many of them have long tails; but not one kind of monkey in Asia or Africa has a prehensile tail. In South America, however, we find apes (such as the *Howling Monkeys* and the *Spider Monkeys*) which have tails most perfectly prehensile, for they are naked beneath towards the tip, and on that account can be applied more closely and firmly to any object grasped more firmly by the tail than they could be grasped were the tail entirely hairy. The tail, indeed, is not only capable of alone supporting the weight of the body, but even of seizing a small movable object, and bringing it in as a hand would do to the mouth.

Monkeys may have long or they may have short tails, and there are some which have no visible tails at all. This is the case with the only European ape—the one which inhabits the Rock of Gibraltar. It is also the case

FIG. 1.—Caudal vertebræ of *Inuus*.

with the Gibbons, or long-armed apes (which we have had living here from time to time, and some of which are so remarkable for their powers of voice). It is also the case with the orang-outang, the chimpanzee, and gorilla, which are as devoid of tails as we are. But are they, and are *we*, really devoid of tails? Practically, of course, we are so, but nevertheless the spinal column has a rudimentary continuation formed of a few very imperfect vertebræ—not sufficiently elongated to form an external projection, so that in the human skeleton a minute tail is to be seen, though none is visible in the unmutilated adult body. In the earliest stages of our existence, however, there is for a short time a real tail of considerable relative extent, but in the development of the body it becomes stationary, so as rapidly to become altogether overshadowed and hidden.

FIG. 2.—The Coccyx. At its upper end are the two prezygapophyses.

As I have said, Madagascar is not inhabited by monkeys, but it is inhabited, instead, by creatures called lemurs, with long fox-like muzzles, of which several are now living in our monkey-house. There also there was lately living another Madagascar creature (a near ally of the lemur) called *Chierogaleus*, and some of these creatures are said to present an interesting peculiarity in the tail.

Although Madagascar is a hot country, yet some of the animals inhabiting it fall into a profound sleep, or torpor, during the dry season, just as our own hedgehog falls into a profound torpor during the winter. Now some of these little lemur-like animals, called *Cheirogalei*, accumulate during a part of the year a great quantity of fat in the tail, which, in consequence, appears much swollen and enlarged. Upon this fat the animals appear to subsist during the other part of the year—not, of course, that they eat it, but that it becomes gradually absorbed, so that as the year comes round, the tail becomes as small again as it was when the fattening process began.

I have shown you how rudimentary the tail is in ourselves. There are many other animals, however, in which there is no tail. In certain bats the bones of the tail are firmly united at their hinder end with the bones of the hip-girdle or pelvis, so that at first sight there seems to be even less tail in them than in ourselves.

Very different is the condition of the tail in other bats, such as in all those which fly about in summer evenings in England.

These creatures fly by means of wings which are hands with fingers enormously long and exceedingly slender, and tied together by skin, their hands being web-fingered as a duck's foot is web-toed. But not only does this skin extend between the long fingers, it also extends from the hands to the sides of the body and legs, forming an enormous membranous wing on each side of the body.

The tail is similarly conditioned. A membrane extends inwards from the whole length of the inside of each leg, and joins the adjacent side of the tail, which is thus held in a membrane called *inter-femoral*, from its situation. In the bat the tail serves as a rudder in flying, but it also performs another function, for by the bending forwards of the tail and the inter-femoral membrane it serves as a cradle in which the infant bat is held on its first appearance in the world.

An "inter-femoral membrane" extending from the legs to the tail between them, also exists in an animal of a widely different form and nature, namely, in the seal.

The two hind legs of the seal are of no use whatever to the animal for progression on land, and the seal thus differs from the sea-bear. The hind-legs of the seal are kept extended out backwards, much in the position in which a man holds his legs when he swims. But they act in quite a different way in swimming from the way our legs act. Being united by an inter-femoral membrane with the tail, the whole mass of the legs and tail together form a sort of fin, which strikes the water as a whole, and so propels the body of the animal along in the water.

Very different is the tail of the whale, porpoise, or such a creature as the manatee or the dugong. None of these creatures have hind-legs at all, or but the merest rudiment

of such in the shape of a few very small bones buried in the flesh. On the other hand, the tail is enormous in bulk, and expands outwards on each side at its hinder end, but in this expansion there are no limb-bones whatever; it is only a cutaneous expansion. This expansion extends horizontally in these animals. Why is this?

FIG. 3.—Dugong.

Fishes, such as the cod, perch, salmon, shark, &c., have the ends of their tails expanded vertically, not horizontally, and it is very evident why.

Fishes swim by bending the tail from side to side and striking the water laterally, as those in any aquarium will show us. They also breathe by the water which flows over their gills.

Whales and porpoises are not fishes, but they are (as is also the manatee and the dugong) aquatic beasts, and they breathe air by lungs as other beasts do. This is the key to the difference in their tails, that is, the horizontal expansion of the hinder end. They require to bring their heads pretty often to the surface to breathe, and the horizontally expanded tail is well fitted to help them in so ascending by its downward blows.

But the tail of the whale or porpoise, strange to say, affords perhaps a partial explanation of the form of the head in these animals. For whales and porpoises are quite remarkable for the large size of their brains. Now the brain is commonly supposed—and in many cases with much reason—to be related to the powers of sensation and imagination which animals possess. Yet it is impossible to think that these marine creatures have any need for exceptionally acute or powerful minds.

But brain stuff is known to be related to motion, no less than to feeling and imagination. Unless our muscles were duly stimulated by nerves and by the brain and spinal cord, they would not act. It may well be then that these animals need all their brains to supply enough nervous energy for the incessant muscular exertion which their habit of life renders necessary in the medium they inhabit. But this explanation alone will not do, for fishes have very small brains. The difference is perhaps due to the fact that whales and porpoises need to maintain a high body temperature, while fishes are cold-blooded and brain stuff is needed to maintain bodily heat no less than for sensation and motion.

The tails of beasts are generally like their bodies, covered with hair. The rat and mouse and certain opossums offer exceptions in their naked, scaly looking tails.

FIG. 4.--The Pangolin (*Manis*).

One animal from Africa, a creature much like a flying squirrel (*Anomalurus*) presents (as its name implies) a very exceptional condition of tail. It is really scaly in part, for underneath it, at a little distance from its root, it is furnished with horny overlapping scales. Such scales are yet more developed in another beast—the manis or pangolin—but then in this latter animal the whole body and limbs are thus invested and not part of the tail only.

The animal renowned for its curious naked tail—flattened out like a trowel—is the beaver. As to the use of this animal's tail our experienced superintendent, Mr. Bartlett (who is so acute and accurate an observer of animals' habits) assures me that he has often watched beavers when at work building with mud in snow, but in no instance has he seen them make use of the tail as a trowel as has so often been alleged. But the beaver has great *power* in its tail, not only as an organ used in swimming but as a means of sounding an alarm to its comrades. On the approach of an enemy the beaver strikes the surface of the water with its flat tail with such force that it can be heard, on a still night, half a mile off. Upon hearing this signal all the beavers in the neighbourhood quickly dive under the water.

The beavers which still linger in European rivers have now ceased to construct dams as do their American fellows. It is an interesting fact, however, that they still retained this habit in Europe down to the time of Albertus Magnus, who of course knew nothing of the habits of the beavers of the then undiscovered America.

In the Zoological Gardens are creatures which are provided with exceptionally powerful tails—for land animals—I mean the kangaroos. These creatures make use of their tails not only sometimes to carry grass, and to a certain extent in their long jumps, but constantly when sitting with the fore part of the body raised, and in this position they often raise themselves high up on their extended hind legs and on their tail as on a strong tripod, at which time they have a most comic appearance.

And this brings me to speak of another matter. As I have said the sloths are fitted to live in trees not by any peculiar development of tail, but in other ways. Certain gigantic extinct allies of sloths, however, were fitted for a forest life and to live entirely on the foliage of trees by their tails. Such extinct beasts were the *Mylodon* and *Megatherium*, creatures equalling or exceeding the rhinoceros in bulk.

The modification of tail specially adapted for forest life with which we have as yet met, has been a *prehensile tail*. This we have seen in the kinkajou and in howling and spider monkeys. Many other beasts, how-

ever, of very different kinds are provided with prehensile tails.

Amongst others may be mentioned tree-porcupines, certain opossums, and a small ant-eater. All these animals live on trees. But the mylodon and megatherium—though forest animals living in all probability exclusively on the foliage of trees, were far too bulky to climb them, or to be supported by their branches. They appear to have fed thus: raising themselves on their hind legs and tail (as on a tripod—like the kangaroos) they embraced trees with their powerful arms, and swaying them to and fro, gradually prostrated them in order to feed upon their leaves. It has been objected to this view of their probable habits, that if they acted in this way they must often get their heads broken. Well, strange to say, the heads of some fossils *have* had their heads broken and healed again, and their skull was specially constructed so as to obviate to a considerable extent the danger of fatal consequences ensuing from accidents of that kind.

The tails of some beasts are, as I have said, exceptionally naked. The tails of others, however, are exceptionally hairy. Such is the case with the horse, which is called "long-tailed" when the tail is adorned with a clothing of very long hairs.

(*To be continued.*)

OUR ASTRONOMICAL COLUMN

BIELA'S COMET IN 1852.—In view of the probable approach to the earth's orbit of the two heads of Biela's comet in the present year, it is not without interest to recall the circumstances under which these bodies were last observed in the autumn of 1852. As soon as the calculated place of what was assumed to be the principal comet of 1846, according to Santini, was sufficiently removed from the sun's place to afford a chance of discovery, a search was commenced at several European observatories, notably by Secchi, at the Observatory of the Collegio Romano at Rome. The comet was not found in its computed position, and the cause of this is now known to have been the abandonment by Santini of his old semi-axis major, founded originally upon Damoiseau's calculation of the perturbations of mean motion between the appearances in 1805-6 and 1826, and the observations of those years and the substitution of a value deduced by Plantamour from the observations in 1845-46; had the original semi-axis been retained the comet would have been readily found by means of Santini's computations. Extending the limits of the search, therefore, Secchi detected a faint comet on the morning of August 26, 1852, some 6° from the calculated place, which Prof. Peters of Altona immediately pointed out as probably one portion of Biela's comet, from the rate and direction of its motion, as, indeed, it proved to be. (In *Memorie dell' Osservatorio del Collegio Romano, anni* 1852-55, the discovery is dated, by a misprint, August 16, civil reckoning, the first observation was made on August 25, at 16h. 14m. M.T.) This object was observed on several subsequent mornings, and on September 16 Secchi found the other head of the comet, following that previously observed about two minutes of time, and about half a degree to the south. With the great refractor at Pulkowa, M. Otto Struve found Secchi's comet of August 26, on September 18 (astronomical), or immediately after the notice reached him, and two mornings later, he observed both heads. Mr. James Breen, to whom Prof. Challis had intrusted the Northumberland equatorial at Cambridge for a search for the comet, found one portion of it on September 8, and observed it further on September 16 and 21. At Berlin one head was detected on September 17, and reobserved on September 22. M. Otto Struve, in his account of the Pulkowa observations, calls that head of the comet which was first observed by Secchi on August 25, A, and that found on September 15, using now astronomical dates, he calls B; the latter was the north-preceding comet, the former the south-following one. A discussion of the observations of both heads, twenty-two in number, showed that those at Cambridge referred to A on all three mornings, and those at Berlin to B; both nuclei were observed at Rome on September 19 and 20, and at Pulkowa on September 20, 23, and 25. The appearance of the two portions of the comet is best described in M. Otto Struve's memoir, which is also accompanied by two admirably executed drawings, depicting their relative aspect on September 20 and 25, B on September 18 was at least 30″ in diameter, with sensible brightening in the centre, but no decided nucleus, and the light of the comet was about equal to that of a star of Argelander's ninth magnitude. On September 20 A was easily seen with the finder of the large refractor, both heads were of about equal brightness, B might be a little the brighter, and exhibited a distinct nucleus; the nucleus of A was not so distinct as that of B, and there was a greater brightness of the nebulosity, as well as an extension of it in the direction of B; the apparent diameters about 1′ and 40″; the diameter of B, which was circular, was estimated 40″. On September 23 A was notably fainter than B, and without nucleus; the lengthened form of A was only seen with difficulty, but the sky was not quite transparent. On September 25 there was a remarkable change as compared with the relative appearance of the two heads five days before; A was materially fainter than B; the latter was very distinct in the finder, while the place of the former was hardly suspected; diameter of A about 30″, that of B from 50″ to 60″. A was round, B slightly oblong; the brightest part of A was not in the centre of the nebulosity, but in the direction of B, and the nucleus of B was in the opposite direction to A, the brightest part of the nebulosity unequally distributed about the nucleus of B being turned away from A; the position-angle of this direction was 286°. On September 28, the last day of observation, the moonlight was strong, and B only was seen with difficulty. We give these details, not remembering to have seen them reproduced in this country; but the description fails to convey the impression made by comparing M. Otto Struve's drawings of September 20 and 25; were it not that we know to the contrary, it might almost be inferred therefrom that one portion of the comet had revolved round the other to the extent of 180°; their relative appearance had been wholly interchanged, and it will be remembered that about February 12, 1846, the secondary comet much exceeded in brightness the primary one, though this continued only three or four days, when the latter resumed its previous decided superiority. There was thus, as M. Struve remarks, the same interchange of brightness between the two nuclei at both appearances, and this he is inclined to attribute to a mutual action. It may, however, be remarked that the distance between them in 1852 was, according to Hubbard, 0·0193, or about 1,750,000 miles, which seems to militate against such an explanation, and rather to induce an idea of action inherent in the separate comets, or of influence exercised upon them through their approach to the sun. At M. Struve's observations of September 20, using Hubbard's elements, we find the distance of A from the earth was 1·492, and that of B, 1·483; while on September 25, the distance of A was 1·525, and of B, 1·511; so that there was no marked change of distance between the dates of his drawings.

VARIABLE STARS.—The following are Greenwich mean times of geocentric minima of *Algol* observable in this country during the last three months of the present year:—

		h. m.			h. m.			h. m.
Oct.	6 ...	15 57·6	Nov.	1 ...	11 16·1	Dec.	8 ...	17 52·1
	9 ...	12 46·2		3 ...	8 4·9		11 ...	14 41·2
	12 ...	9 34·9		18 ...	16 9·2		14 ...	11 30·3
	15 ...	6 23·6		21 ...	12 58·2		17 ...	8 19·4
	29 ...	14 27·3		24 ...	9 47·1		20 ...	5 8·5
				27 ...	6 36·1		31 ...	16 25·0

Minima of S Cancri occur on

	h. m.		h. m.
Oct. 7	9 17·6	Dec. 3	6 56·3
26	8 30·5	12	18 33·0
Nov. 14	7 43·3	22	6 9·9
		31	17 46·3

R Leporis will be at a maximum on October 3, and χ Cygni at a minimum on December 6 according to Schönfeld's elements, but the average period of late years, 406 days added to Schmidt's last well-determined epoch of minimum, October 11, 1878, would fix the next minimum on November 21; observations of this star are much to be desired, owing to the irregularities in the period which have been recently evident; the star is a little brighter than 13m. at minimum.

The star observed six times at Bonn in 1863 in R.A. 22h. 28m. 16·9s., Decl. $-8^\circ\ 21'\ 19''$ for 1855·0 is variable from 9m. to below 13·5m., and though long notified as a variable star, appears to have been little observed. It was invisible on November 9, 1874. Cooper estimated it 9m. on October 27, 1848, and it was equally bright in August, 1855. This object is not in Schönfeld's catalogue of 1875.

THE NEW MINOR PLANETS.—Names continue to be assigned to the newer discoveries in this group, though they can hardly be said to be invariably euphonious, at least to English ears. The last circular of the *Berliner Astronomisches Jahrbuch* states that the following selection has been made by the Berlin astronomers at the request of the discoverer, Herr Palisa, of Pola: for No. 192, *Nausikaa;* No. 195, *Eurykleia;* No. 197, *Arete;* and for No. 201, *Penelope.*

THE OUTER SATELLITE OF MARS.—The satellite *Deimos* was observed by Mr. A. A. Common, of Ealing, on the morning of September 22, or three weeks earlier than Prof. Asaph Hall expected that it would be observable with the Washington 26-inch refractor. Mr. Common's angle of position, measured with his new 36-inch silver-on-glass reflector, differs only $+1^\circ{\cdot}8$ from that assigned by Prof. Hall's elements.

NOTES

WE regret to have to announce the death of Mrs. Norman Lockyer, an occasional contributor to this journal and translator of several French works on popular science. Her husband's scientific work for the last eleven years owes whatever it may possess of merit to her constant interest, encouragement, and assistance. Her untimely death will be a shock to many men of science in many lands to whom she was personally known.

IT will interest many of our readers to learn that Dr. William Jack, who has been an occasional contributor to NATURE, and is well known to most of those connected with it, has been unanimously elected to the chair of Mathematics in Glasgow University, recently vacated by Prof. Blackburn.

BARON FERDINAND VON MÜLLER, Government botanist of Victoria, has been rewarded for his Colonial services as a naturalist with the Knight Commandership of the Order of St. Michael and St. George.

THE death, on the 13th inst., is announced, of Mr. W. Wilson Saunders, F.R.S.

THE 110th anniversary of the birthday of Alexander von Humboldt was publicly celebrated by the Society of Cosmophiles at Leipzig on the 14th inst. A festival address was delivered by the secretary of the Society, Herr E. Haynel.

AT the Berlin meeting of the German Astronomical Society on September 5-8 last the series of scientific communications was opened by Dr. Förster, who minutely described the innovations recently made at the Berlin Observatory, which he subsequently invited the meeting to inspect. Prof. Bruhns, of Leipzig, spoke on the progress made in calculating the orbits of comets, Prof. Gylden, of Stockholm, pointing out a shorter method in these calculations. Prof. Winnecke then gave a description of the new Strassburg Observatory, and was followed by Dr. Drechsler, of Dresden, who made a communication on the collections belonging to the Royal Mathematical Saloon of Dresden. The last paper was by Prof. Schaffarick on variable stars. At the subsequent inspection of the Berlin Observatory the excellent arrangements to prevent damage to the instruments from variations in temperature were particularly admired. Great admiration was also elicited by the Astro-Physical Observatory at the Telegraphenberg, near Potsdam. The Society will meet again at Strassburg in 1881.

WE have already, in our "Notes," chronicled the "inauguration" of the Water Supply Exhibition at the Alexandra Palace by the Lord Mayor, on August 14. The exhibition is being held under the auspices of the committee for promoting a permanent water supply museum to be established somewhere in London, the lessees of the Palace kindly placing their exhibition court at the disposal of the committee for the purpose. The "inauguration" was fixed at a date when the exhibition was in a very rudimentary state; but as the Lord Mayor had given his patronage, and as he was leaving town on the 15th, it was felt undesirable to postpone it. The exhibition has grown slowly since then, though it is still far from coming up to the scheme as sketched out by the committee. The nature of the exhibition precludes its growing very rapidly, for the scheme does not appeal to many classes of exhibitors, and no commercial benefits are likely to accrue to contributors except in a few of the trade sections. It is understood that the Lord Mayor, accompanied by some of the provincial mayors, will visit the exhibition to-morrow (Friday), and will be entertained at lunch. This visit may help to draw attention to the effort to establish what might be made a very valuable institution.

THE statue to Arago was unveiled at Perpignan on September 20. Arago is represented as speaking and extending his arm towards the heavens. There are also three bas-reliefs. The first shows young Arago preparing for his examination at the Polytechnic School and studying without any master at the Old Perpignan fortifications. The second is the triumphant march from the Observatory to the Hotel de Ville, when Arago proclaimed the Republic in 1848; the great astronomer is leaning on Emanuel, his eldest son, now a member of the French Senate. The third relief represents Arago almost blind, sitting on his bed and composing his memoirs; Madame Langier, his niece, is writing what the great dying astronomer is dictating.

A METEOROLOGICAL station is to be established at Mont de Mignons, near Nice.

ONE feature of the last eruption of the remarkable volcano of Kilauea, in the Sandwich Islands, is the fact that the great molten lake of lava, occupying a huge caldron nearly a mile in width, and known as the "South Lake," was drawn off subterraneously, giving no warning of its movements and leaving no visible indication of its pathway or the place of its final deposit. "Other eruptions," writes Dr. Coan to Prof. Dana, in a letter dated June 20, "have blazed their way on the surface to the sea, or while on their subterranean way have rent the superincumbent beds, throwing out jets of steam or of sulphurous gases, with here and there small patches or broad areas of lava. But as yet no surface-marks of this kind reveal the silent, solemn course of this burning river. One theory is that it flowed deep in subterranean fissures, and finally disembogued far out at sea. Our ocean was much disturbed during those days, and we had what might be

called a tidal wave of moderate magnitude." The old process of replenishment which had gone on since the last eruption in 1868, is reported to have begun again, and after another decade another disgorgement may take place.

THE Indian correspondent of the *Times* has recently referred to the terrible famine now prevailing in Cashmere, the immediate cause of which is no doubt the long-continued drought which has prevailed in the country. This drought unfortunately followed upon a snowfall in the winter and spring of 1877-78 in magnitude and duration unprecedented in Cashmere, or probably in any other country. Some interesting details of this extraordinary snowfall are given in a paper in the just-issued number of the *Journal* of the Asiatic Society of Bengal by Mr. Lydekker. Early in the month of October, 1877, snow commenced to fall in the valley and mountains of Cashmere, and from that time up to May, 1878, there seems to have been an almost incessant snowfall in the higher mountains and valleys; indeed, in places it frequently snowed without intermission for upwards of ten days at a time. At Dras, which has an elevation of 10,000 feet, Mr. Lydekker estimated the snowfall from the native account, as having been been from 30 feet to 40 feet thick. The effects of this enormous snowfall were to be seen throughout the country. At Dras the well-built travellers' bungalow, which had stood some thirty years, was entirely crushed down by the weight of the snow which fell upon it. In almost every village of the neighbouring mountains more or less of the loghouses had likewise fallen, while at Gulmarg and Sonamarg, where no attempt was made to remove the snow, almost all the huts of the European visitors were utterly broken down by it. In the higher mountains whole hillsides have been denuded of vegetation and soil by the enormous avalanches which swept down them, leaving vast gaps in the primeval forests and choking the valleys below with the *débris* of rocks and trees. As an instance of the amount of snow which must have fallen in the higher levels, Mr. Lydekker mentions the Zogi Pass, leading from Cashmere to Dras, which has an elevation of 11,300 feet. He crossed this early in August last year, and he then found that the whole of the ravine leading up to the pass from the Cashmere side was still filled with snow, which he estimated in places to be at least 150 feet thick. In ordinary seasons this road in the Zogi Pass is clear from snow some time during the month of June. As another instance of the great snowfall, Mr. Lydekker takes the valley leading from the town of Dras up to the pass separating that place from the valley of the Kishengunga River. About the middle of August almost the whole of the first-mentioned valley, at an elevation of 12,000 feet, was completely choked with snow, which in places was at least 200 feet thick. In the same district all passes over 13,000 feet were still deep in snow at the same season of the year. Mr. Lydekker gives other instances of snow lying in places in September where no snow had ever before been observed after June. As to the destruction of animal life, in the Upper Wardwan Valley large numbers of ibex were seen imbedded in snow; in one place upwards of 60 heads were counted, and in another not less than 100. The most convincing proof, however, of the havoc caused among the wild animals by the great snowfall is the fact that scarcely any ibex were seen during last summer in those portions of the Wardwan and Tilail Valleys which are ordinarily considered as sure finds. So also the red bear and the marmot were far less numerous than usual. Mr. Lydekker estimates that the destruction to animal life caused by the snow has far exceeded any slaughter which could be inflicted by sportsmen during a period of at least five or six years.

PROF. ADLER has published a paper on the excavations at Olympia from which it appears that altogether the following numbers of antiquities have been found there:—1,328 different sculptures, 7,464 bronzes, 696 inscriptions, 2,935 coins, 2,094 terra-cotta objects, and 105 different objects made of glass, horn, lead, &c.

BARON TAYLOR, the celebrated founder of a number of literary and scientific associations for assisting literary men, artists, and men of science, has died in Paris at the age of ninety. The aggregate income of the seven associations which he founded amounts to about 10,000*l*. The son of an Englishman, he was born in Brussels, and became a Frenchman by naturalisation. He made a number of explorations in Spain and Egypt—the Luxor obelisk being brought over mainly by his exertions. He was appointed a member of the French Senate by Napoleon III. in 1869, owing to which circumstance his funeral did not take place at the public expense, although a similar honour was paid to M. Claude Bernard, who had been his colleague in the Imperial Senate.

IN a recent part of the *Zeitschrift für Biologie*, Herr Carl Nörr published the results of some experiments made by him with a view of determining the power of the human ear for distinguishing different intensities of sound. The experiments were made with leaden balls, which from a measured height were dropped on to an iron plate; thus it was possible to determine the exact intensity of the sounds by means of the distances and weights of the balls. Herr Nörr made seven different series of experiments, each with a definite intensity of sound, which varied from a just perceptible one to one 500,000 times as loud. The results showed that the percentage of correct determinations made by the ear, decreased as the difference in intensity between any two sounds compared increased. When the difference in intensities remained the same, the percentage of correct determinations was the same both for loud as well as for scarcely audible sounds. A calculation of the numbers of correct determinations found by the experiments showed that the power of distinguishing the intensities of sound follows Fechner's law most closely, *i.e.*, that the measures of sensitiveness stand in the same proportion as the reciprocate values of the square roots of difference of intensities of sounds.

WE notice among the interesting communications made at the late Anthropological Congress at Moscow, a communication, by Prof. Inostrantseff, on the discovery of very numerous remains of man of the stone period, on the shores of Lake Ladoga. All these remains are accompanied by bones of *Bos primigenius*, bear, wolf, and seal, and belong to the post-glacial epoch.

THE Russian collections of stone implements at the Moscow Archæological Exhibition were very rich, and if we take into consideration that this subject was quite neglected in Russia until the last few years, we must conclude that Russia will soon become a wide field for the exploration of this period of human civilisation. The ease with which these remains are excavated, the immense quantities in which they are found, both on the shores of the northern lakes and on the banks of southern rivers, and the very good state in which the bones are preserved (as, for instance, the skull and bones discovered by Count Ouvaroff, already mentioned in NATURE), will surely much contribute to the development of these studies in Russia.

IN a recent paper on the radiometer to the Vienna Academy, Dr. Pulnj criticises Reynold's evaporation theory and Zollner's emission theory, and holds that neither evaporation nor emission can be the sole or chief cause of radiometric movements, else there should not be a decrease in the motion when a certain degree of rarefaction has been passed. It must be supposed that the reaction-force arising from any emission of particles which takes place is extremely small in comparison with the forces arising through rebound of molecules of gaseous material already present, so that the motion is exclusively or chiefly con-

ditioned by these. With this assumption the decrease of the motion is thus explained by Dr. Puluj, according to the kinetic theory of gas: With full atmospheric pressure the reaction-force aroused on the vanes is too small to overcome the resistance of friction and the air. With sufficient rarefaction it overcomes these resistances, and the motion begins. If the reaction-force, like the internal friction, decreases but very slowly with the pressure, the velocity of motion reaches, at a certain pressure, the maximum, and on further rarefaction it decreases, because not only the resistance of the air, but also the reaction-force awakened becomes smaller with the smaller number of rebounding molecules. In an absolutely vacuous space, the motion must quite cease, if no emission of particles took place from the vanes. Dr. Puluj further describes a radiometer, consisting of a fixed cross with mica vanes blackened on one side, and a very thin cylindrical glass cover. The outer vane edges were 2 mm. distant from the glass. The glass cylinder turned, on illumination, in an opposite direction to that in which the cross should turn. The object of the experiment was to prove that the movements of the radiometer could also not be explained by air currents.

PROF. KLINKERFUES, the director of the Göttingen Observatory, has taken out a patent for a new invention in telegraphy. The professor has discovered a method by which up to eight different messages may be sent simultaneously by the same wire, an apparatus at the receiving end printing the messages separately and all at the same time. The importance of this invention to telegraphy generally needs no comment.

AT Cannstatt (near Stuttgart) a horticultural exhibition will be held from the 25th till the 29th inst.

A NEW periodical devoted to aëronautics will be published at St. Petersburg from January next, under the name of *The Aëronaut* (*Vozdukhoplavatel*). Its editor will be M. Klinder.

A SHOCK of earthquake was felt at Lyons on the 9th inst. at 7 A.M. It proceeded in a south-northerly direction and lasted two seconds.

DR. KING's annual report on the Cinchona Plantations in British Sikkim for the year ending March 31 last, together with that of the Government quinologist, Mr. C. H. Wood, are extremely satisfactory, both with regard to the cultivation and extension of the most valuable species of cinchona as well as in the preparation of the cinchona febrifuge. Of red bark trees, *Cinchona succirubra*, 353,415 were planted out, namely, 24,725 to replace old plants uprooted in taking the bark crop, and 328,690 on new land. Special attention has been paid to the most valuable of all the medicinal barks, *C. calisaya*, known as the yellow bark tree. Of this kind there were in the nursery beds at the close of the year 60,000 cuttings and seedlings in the Mungpoo division and 1,000 in the Sittong division, all of which were nearly ready at the time the report was written, for transfer to the permanent plantations. The first crop of bark of this species was obtained in the Sikkim plantation during the past season, the result showing a yield of about 1,400 lbs. of dry bark. This species we are, however, informed, is very capricious in growth, and no locality with perfectly suitable climatic conditions for it has yet been found in British Sikkim. For the purpose of ascertaining correctly the conditions under which the Dutch have succeeded in growing the tree cheaply in Java, Dr. King has received authority to proceed thither. The summary of all kinds of cinchona plants planted out during the year under review shows a total of 4,028,055, of which 3,589,965 were of the red bark species. As nearly 300,000 lbs. of bark, the produce of the previous year, remained in the quinologist's hands, it was not deemed advisable to collect a larger crop than was really necessary to meet the requirements of the febrifuge factory, consequently the total crop of bark taken amounted to only 261,659 lbs. The continuous increase in the amount of febrifuge manufactured by the Government quinologist is very marked, for while in the year 1874-75 only 48 lbs. were produced, which in the following year had increased to 1,940 lbs., in the year under review no less a quantity than 7,007 lbs. were turned out, but notwithstanding this rapid development of the manufacture the increasing confidence in the efficacy of the febrifuge has raised the demand for it so much that the consumption of the past year greatly exceeded the quantity manufactured. To meet this growing demand the scale of manufacture at Mungpoo has been extended. Whether the febrifuge now so largely manufactured in India is capable of being improved by eliminating any of its constituents is a question still under the consideration of the committee appointed in 1877. It is satisfactory, however, to find that the further experience in the use of the drug during the past year has increased the confidence of the public and of the medical profession in its virtues. The question of manufacturing a superior drug which would not be exposed to the prejudices which have so long delayed the free distribution of the present febrifuge is still under the consideration of the committee before referred to. It is stated that it will probably be found advisable to manufacture at a slightly increased cost a preparation composed of the three sulphates, cinchonidine, cinchonine, and quinine in conjunction.

THE Congress of Viticulturists which took place at Coblenz on the 4th inst. will meet at Heilbronn next year, and the apicultural meeting which was held at Prague on the 7th inst. selected Cologne as a meeting place for 1880.

THE additions to the Zoological Society's Gardens during the past week include two African Sheep (*Ovis aries*) from West Africa, presented by Mr. R. B. N. Walker, C.M.Z.S.; two Ring-tailed Coatis (*Nasua rufa*) from South America, presented respectively by Mr. Chas. S. Barnes and Mr. Percy Brewis; a Common Fox (*Canis vulpes*), British, presented by Mr. Jas. Wheatley; a Caracal (*Felis caracal*), a Secretary Vulture (*Serpentarius reptilivorus*) from South Africa, presented by Dr. Holub; two Dunlins (*Tringa cinclus*), a Turnstone (*Strepsilas interpres*), a Ringed Plover (*Œgialitis hiaticula*), British, presented by Mr. Edmund A. T. Elliot; two Common Cuckoos (*Cuculus canorus*), British, presented respectively by Mrs. Bolton and Miss C. Bealey; a Turquoisine Parrakeet (*Euphema pulchella*) from New South Wales, presented by Mr. J. Fraser; a Square-spotted Snake (*Oxyrrhopus doliatus*) from South America, presented by Mr. H. Colgate; a Chacma Baboon (*Cynocephalus porcarius*), a Yellow Baboon (*Cynocephalus babouin*), an Isabelline Antelope (*Cervicapra isabellina*), a Sociable Vulture (*Vultur auricularis*), two Tawny Eagles (*Aquila nævioides*), two Cape-crowned Cranes (*Balearic regulorum*), a Stanley Crane (*Tetrapteryx paradisea*), from South America, deposited.

HISTORY AND METHODS OF PALÆONTOLOGICAL DISCOVERY[1]

II.

WHILE the Paris Basin was yielding such important results for palæontology, its geological structure was being worked out with great care. The results appeared in a volume by Cuvier and Alex. Brongniart, chiefly the work of the latter, published in 1808.[2] This was the first systematic investigation of tertiary strata. Three years later, the work was issued in a more extended form. The separate formations were here carefully distinguished by their fossils, the true importance of which for this purpose being distinctly recognized. This advance was not accepted without some opposition, and it is an

[1] An Address, delivered before the American Association for the Advancement of Science, at Saratoga, N.Y., August 28, 1879, by Prof. O. C. Marsh, President. Continued from p. 499.

[2] "Essai sur la Géographie minéralogique des Environs de Paris." 4to, 1808.

interesting fact that Jameson, who claimed for Werner the theory here put in practice, rejected its application, and wrote as follows: "To Cuvier and Brongniart we are indebted for much valuable information in their description of the country around Paris, but we must protest against the use they have made of fossil organic remains in their geognostical descriptions and investigations."[1]

William Smith (1769-1839), "the father of English geology," had previously published a "Tabular View of the British Strata." He appears to have arrived independently at essentially the same view as Werner in regard to the relative position of stratified rocks. He had determined that the order of succession was constant, and that the different formations might be identified at distant points by the fossils they contained. In his later works, "Strata identified by Organised Fossils," published in 1816-20, and "Stratigraphical System of Organised Fossils," 1817, he gave to the world results of many years of careful investigations on the secondary formations of England. In the latter work he speaks of the success of his method in determining strata by their fossils, as follows: "My original method of tracing the strata by the organised fossils imbedded therein, is thus reduced to a science not difficult to learn. Ever since the first written account of this discovery was circulated in 1799, it has been closely investigated by my scientific acquaintances in the vicinity of Bath, some of whom search the quarries of different strata in that district, with as much certainty of finding the characteristic fossils of the respective rocks, as if they were on the shelves of their cabinets."

The systematic study of fossils now attracted attention in England, also, and was prosecuted with considerable zeal, although with less important results than in France. An extensive work on this subject, by James Parkinson, entitled "Organic Remains of a Former World," was begun in 1804, and completed in three volumes in 1811. A second edition appeared in 1833. This work was far in advance of previous publications in England, and, being well illustrated, did much to make the collection and study of fossils popular. The belief in the geological effects of the deluge had not yet lost its power, although restricted now to the later deposits; for Parkinson in his later edition, wrote as follows: "Why the earth was at first so constituted that the deluge should be rendered necessary—why the earth could not have been at first stored with all those substances, and endued with all those properties which seem to have proceeded from the deluge—why so many beings were created, as it appears, for the purpose of being destroyed—are questions which I presume not to answer."

William Buckland (1784-1856), published in 1823 his celebrated "Reliquiæ Diluvianæ," in which he gave the results of his own observations in regard to the animal remains found in the caves, fissures, and alluvial gravels of England. The facts presented are of great value, and the work was long a model for similar researches. Buckland's conclusions were, that none of the human remains discovered in the caves were as old as the extinct mammals found with them, and that the deluge was universal. In speaking of fossil bones found in the Himalayan Mountains, he says: "The occurrence of these bones at such an enormous elevation in the region of eternal snow, and consequently in a spot now unfrequented by such animals as the horse and deer, can, I think, be explained only by supposing them to be of antediluvian origin, and that the carcases of the animals were drifted to their present place, and lodged in sand, by the diluvial waters.

The foundation of the "Geological Society of London," in 1807, marks an important point in the history of palæontology. To carefully collect materials for future generalisations, was the object in view, and this organisation gradually became the centre in Great Britain for those interested in geological science. The society was incorporated in 1826, and has since been the leading organisation in Europe for the advancement of the sciences within its field. The Geological Society of France, established at Paris in 1832, and the German Geological Society, founded at Berlin in 1848, have likewise contributed largely to geological investigations in these countries, and to some extent in other parts of the world. In the publications of these three societies the student of palæontology will find a mine of valuable materials for his work.[2]

The systematic study of fossil plants may be said to date from the publication of Adolphe Brongniart's "Prodrome," in 1828.[3]

[1] Translation of Cuvier's Discourse. Note K. (B.), p. 103, 1817.
[2] "Recherches sur les Poissons fossiles," 1833-45.
[3] "Prodrome d'une Histoire des Végétaux fossiles." 8vo. Paris, 1828.

This was very soon followed by his larger work, "Histoire des Végétaux fossiles," issued in 1828-48. Brongniart pursued the same method as Cuvier and Lamarck, viz.: the comparison of fossils with living forms, and his results were of great importance. In his "Tableau des Genres Végétaux fossiles," &c., published in Paris in 1849, he gives the classification and distribution of the genera of fossil plants, and traces out the historical progression of vegetable life on the globe, as he had done to a great extent in his previous works. He shows that the cryptogamic forms prevailed in the primary formations; the conifers and cycads in the secondary, and the higher forms in the tertiary, while four-fifths of living plants are exogens.

In England Lindley and Hutton published, in 1831-37, a valuable work in three volumes, entitled, "Fossil Flora of Great Britain." This work was illustrated by many accurate plates, in which the plants of the coal formation were especially represented. Henry Witham also published two works in 1831 and 1833, in which he treated especially of the internal structure of fossil plants. "Antediluvian Phytology," by Artis, was published in London in 1838. Bowerbank's "History of the Fossil Fruits and Seeds of the London Clay" appeared in 1843. Hooker's memoir "On the Vegetation of the Carboniferous Period, as compared with that of the Present Day," published in 1848, was an important contribution to the science. Bunbury, Williamson, and others, also published various papers on fossil plants. This branch of palæontology, however, attracted much less attention in England than on the Continent.

In Germany the study of fossil plants dates back to the beginning of the century. Von Schlotheim, a pupil of Werner, published in 1804 an illustrated volume on this subject. A more important work was that of Count Sternberg, issued in 1820-38, and illustrated with excellent plates. Cotta, in 1832, published a book with the title, "Die Dendrolithen," in which he gave the results of his investigations on the inner structure of fossil plants. Von Gutbier, in 1835, and Germar in 1844-53, described and figured the plants of two important localities in Germany. Corda's "Beiträge zur Flora der Vorwelt," issued at Prague in 1845, was essentially a continuation of the work of Sternberg. Unger's "Chloris protogæa," 1841-45, "Genera et Species Plantarum Fossilium," 1850, and his larger work, published in 1852, are all standard authorities. In the latter the theory of descent is applied to the vegetable world. Schimper and Mougeot's "Monograph on the Fossil Plants of the Vosges," 1845, was well illustrated, and contained noteworthy results.

Göppert, in 1836, published a valuable memoir entitled "Systema Filicum Fossilium," in which he made known the results of his study of fossil ferns. In the same year this botanist began a series of experiments, in which he attempted to imitate the process of fossilisation, as found in nature. He steeped various animal and vegetable substances in waters holding, some calcareous, others siliceous, and others metallic matter in solution. After a slow saturation the substances were dried and exposed to heat until the organic matters were burned. In this way Göppert successfully imitated various processes of petrifaction, and explained many things in regard to fossils that had previously been in question. His discovery of the remains of plants throughout the interior of coal did much to clear up the doubts about the formation of that substance. In 1841 Göppert published an important work, in which he compared the genera of fossil plants with those now living. In 1852, another extensive work by this author appeared, entitled "Fossile Flora des Uebergangs-Gebirges."

Andræ, Braun, Dunker, Ettingshausen, Geinitz, and Goldenberg, all made notable contributions to fossil botany in Germany, during the period we are now considering.

The systematic study of invertebrate fossils, so admirably begun by Lamarck, was continued actively in France. The tertiary shells of the Seine Valley were further investigated by Defrance, and especially by Deshayes, whose great work on this subject was begun in 1824.[1] Des Moulin's essay on "Sphérulites" in 1826, Blainville's memoir on "Belemnites" in 1827, Férussac's various memoirs on land and fresh water fossil shells, were valuable additions to the subject. A later work of great importance was D'Orbigny's "Paléontologie française," 1840-44, which described the mollusca and radiates in detail, according to formations. The other publications of this author are both numerous and valuable. Brongniart and

[1] "Description des Coquilles fossiles des Environs de Paris." 3 vols. Paris, 1824-37.

Desmarest's "Histoire naturelle des Crustaces fossiles," published in 1822, is a pioneer work on this subject. Michelins' memoir on the fossil corals of France, 1841-46, was another important contribution to palæontology. Agassiz's works on fossil echinoderms and molluscs are valuable contributions to the science. The works of d'Archiac, Coquand, Cotteau, Desor, Edwards, Haime, and de Verneuil, are likewise of permanent value.

In Italy, Bellardi, Merian, Michellotti, Phillipi, Zigno, and others, contributed important results to palæontology.

In Belgium, Bosquet, Nyst, Koninck, Ryckholt, van Beneden, and others, have all aided materially in the progress of the science.

In England, also, invertebrate fossils were studied with care, and continued progress was made. Sowerby's "Mineral Conchology of Great Britain," in six volumes, a systematic work of great value, was published in 1812-30, and soon after was translated into French and German. Its figures of fossil shells are excellent, and it is still a standard work. Miller's "Natural History of the Crinoidea," published at Bristol, in 1821, and Austin's later monograph, are valuable for reference. Brown's "Fossil Conchology of Britain and Ireland" appeared in 1839, and Brodie's "History of the Fossil Insects of England" in 1845. Phillips' illustration of the geology of Yorkshire, 1829-36, and his work on the "Palæozoic Fossils of Cornwall, Devonshire, and West Somerset," 1843, contained a great deal of original matter in regard to fossil remains. Morris's "Catalogue of British Fossils," issued in 1843, and the later edition in 1854, is most useful to the working palæontologist. The memoirs of Davidson on the Brachiopoda, Edwards, Forbes, Morris, Lycett, Sharpe, and Wood, on other Mollusca, Wright on the Echinoderms, Salter on Crustacea, Busk on Polyzoa, Jones on the Entomostraca, and Duncan and Lonsdale on Corals, are of especial value. King's volume on Permian Fossils, Mantel's various memoirs, Dixon's work on the Fossils of Sussex, 1850, and McCoy's works on Palæozoic Fossils all deserve honourable mention. Sedgwick, Murchison, and Lyell, although their greatest services were in systematic geology, each contributed important results to the kindred science of palæontology during the period we are reviewing.

In Germany, Schlotheim's treatise, "Die Petrifactenkunde," published at Gotha in 1820, did much to promote a general interest in fossils. By far the most important work issued on this subject was the "Petrifacta Germanica," by Goldfuss, in three folio volumes, 1826 to 1844, which has lost little of its value. Bronn's "Geschichte der Natur," 1841-46, was a work of great labour, and one of the most useful in the literature of this period. The author gave a list of all the known fossil species, with full reference, and also their distribution through the various formations. This gave exact data on which to base generalisations, hitherto of comparatively little value.

Among other early works of interest in this department may be mentioned Dalman's memoir on "Trilobites," 1828, and Burmeister's on the same subject, 1843. Giebel's well-known "Fauna der Vorwelt," 1847-1856, gave lists of all the fossils described up to that time, and hence is a very useful work. The "Lethæa Geognostica" by Bronn, 1834-38, and the second edition by Bronn and Roemer, 1846-56, is a comprehensive general treatise on palæontology, and the most valuable work of the kind yet published.

The researches of Ehrenberg, in regard to the lowest forms of animals and plants, threw much light on various points in palæontology, and showed the origin of extensive deposits, the nature of which had before been in doubt. Von Buch, Barrande, Beyrich, Berendt, Dunker, Geinitz, Heer, Hörnes, Klipstein, von Münster, Reuss, Roemer, Sandberger, Suess, von Hagenow, von Hauer, Zeiten, and many others, all aided in the advancement of this branch of science. Angelin, Hisinger, and Nilsson, in Scandinavia; Abich, De Waldheim, Eichwald, Keyserling, Kutorga, Nordman, Pander, Rouillier, and Volborth, in Russia; and Pusch in Poland, published important results on fossil invertebrates.

The impetus given by Cuvier to the study of vertebrate fossils extended over Europe, and great efforts were made to continue discoveries in the direction he had so admirably pointed out.

Louis Agassiz (1807-73), a pupil of Cuvier, and long an honoured member of this association, attained eminence in the study of ancient as well as of recent life. His great work on Fossil Fishes[1] deserves to rank next to Cuvier's "Ossemens fossiles." The latter contained mainly fossil mammals and reptiles, while the fishes were left without a historian till Agassiz began his investigations. His studies had admirably fitted him for the task, and his industry brought together a vast array of facts bearing on the subject. The value of this grand work consists not only in its faithful descriptions and plates, but also in the more profound results it contained. Agassiz first showed that there is a correspondence between the succession of fishes in the rocks, and their embryonal development. This is now thought to be one of the strongest points in favour of evolution, although its author interpreted the facts as bearing the other way.

Pander's memoirs on the fossil fishes of Russia form a worthy supplement to Agassiz's classic work. Brandt's publications are likewise of great value; and those of Lund, in Sweden, have an especial interest to Americans, in consequence of his researches in the caves of Brazil.

Croizet and Jobert's "Recherches sur les Ossemens fossiles du Département du Puy-de-Dôme," published in 1828, contained valuable results in regard to fossil mammals. Geoffroy St. Hilaire's researches on fossil reptiles, published in 1831, were an important advance. De Serres and De Christol's explorations in the caverns in the south of France, published between 1829 and 1839, were of much value. Schmerling's researches in the caverns of Belgium, published in 1833-36, were especially important on account of the discovery of human remains mingled with those of extinct animals. Deslongchamp's memoirs on fossil reptiles, 1835, are still of great interest. Pictet's general treatise on palæontology was a valuable addition to the literature, and has done much to encourage the study of fossils.[2] De Blainville, in his grand work, "Ostéographie," issued in 1839-56, brought together the remains of living and extinct vertebrates, forming a series of the greatest value for study. Aymard and Pomel's contributions to vertebrate palæontology are both of value. Gervais and Lartet added much to our knowledge of the subject, and Bravard and Hébert's memoirs are well known.

The brilliant discoveries of Cuvier in the Paris Basin excited great interest in England, and when it was found that the same tertiary strata existed in the south of England, careful search was made for vertebrate fossils. Remains of some of the same genera described by Cuvier were soon discovered, and other extinct animals new to science were found in various parts of the kingdom. König, to whom we owe the name *Ichthyosaurus*, and Conybeare, who gave the generic designation *Pleisosaurus*, and also *Mososaurus*, were among the earliest writers in England on fossil reptiles. The discovery of these three extinct types, and the discussion as to their nature, forms a most interesting chapter in the annals of palæontology. The discovery of the *Iguanodon*, by Mantell, and the *Megalosaurus*, by Buckland, excited still higher interest. These great reptiles differed much more widely from living forms than the mammals described by Cuvier, and the period in which they lived soon became known as the "age of reptiles." The subsequent researches of these authors added largely to the existing knowledge of various extinct forms, and their writings did much to arouse public interest in the subject.

Richard Owen, a pupil of Cuvier, followed, and brought to bear upon the subject an extensive knowledge of comparative anatomy, and a wide acquaintance with existing forms. His contributions have enriched almost every department of palæontology, and of extinct vertebrates especially he has been, since Cuvier, the chief historian. The fossil reptiles of England he has systematically described, as well as those of South Africa. The extinct struthious birds of New Zealand he has made known to science, and accurately described in extended memoirs. His researches on the fossil mammals of Great Britain, the extinct Edentates of South America, and the ancient Marsupials of Australia, each forms an important chapter in the history of our science.

The personal researches of Falconer and Cautley in the Sivalik Hills of India brought to light a marvellous vertebrate fauna of pliocene age. The remains thus secured were made known in their great work "Fauna Antiqua Sivalensis," published in London in 1845. The important contributions of Egerton to our knowledge of fossil fishes and Jardine's well-known work, "Ichnology of Annandale," also belong to this period.

The study of vertebrate fossils in Germany was prosecuted

[1] "Recherches sur les Poissons fossiles," 1833-45.

[2] "Traité élémentaire de Paléontologie," etc., Genève. 4 vols. 1844-46. Second Edition. Paris, 1853-55.

with much success during the present period. Blumenbach, the ethnologist, in several publications between 1803 and 1814, recorded valuable observations on this subject. In 1812 Sömmerring gave an excellent figure of a pterodactyle, which he named and described. Goldfuss's researches on the fossil vertebrates from the caves of Germany, published in 1820-23, made known the more important facts of that interesting fauna. His later publications on extinct amphibians and reptil s were also noteworthy. Jäger's investigations on the extinct vertebrate fauna of Würtemberg, published between 1824 and 1839, were an important advance. To Plieninger's researches in the same region, 1834-44, we owe the discovery of the first triassic mammal *Microlestes*), as well as important information in regard to labyrinthodonts. Kaup's researches on fossil mammals, 1832-41, brought to light many interesting forms, and to him we are indebted for the generic name *Dinotherium*, and excellent descriptions of the remains then known.

Count Münster's "Beiträge zur Petrifactenkunde," published 1843-46, contained several valuable papers on fossil vertebrates, and the separate papers by the same author are of interest. Andreas Wagner wrote on Pterosaurians in 1837, and later gave the first description of fossil mammals of the tertiary of Greece, 1837-40. Johannes Müller published an important illustrated work on the zeuglodonts, in 1849, and various notable memoirs, and Quenstedt, interesting descriptions of fossil reptiles, as well as other papers of value. Rütimeyer's suggestive memoirs are widely known.

Hermann von Meyer's contributions to vertebrate palæontology are by far the most important published in Germany during the period we are now considering. From 1830, his investigations on this subject were continuous for nearly forty years, and his varions publications are all of value. His "Beiträge zur Petrifactenkunde," 1831-33, contains a series of valuable memoirs. His "Palæologica," issued in 1832, includes a synopsis of the fossil vertebrates then known, with much original matter. His great work, "Zur Fauna der Vorwelt," 1845-60, includes a series of monographs invaluable to the student of vertebrate palæontology. This work, as well as his other chief publications, was illustrated with admirable plates from his own drawings. Other memoirs by this author will be found in the "Palæontographica," of which he was one of the editors. In the many volumes of this publication, which began in 1851, and is still continued, will be found much to interest the investigator in any branch of palæontology.

The Palæontographical Society of London, established in 1847, has also issued a series of volumes containing valuable memoirs in various branches of palæontology. These two publications together are a storehouse of knowledge in regard to extinct forms of animal and vegetable life.

It may be interesting here to note briefly the use of general terms in palæontology, as the gradual progress of the science was indicated to some extent in its terminology. At first, and for a long time, the name *fossil* was appropriately used for objects dug from the earth, both minerals and organic remains. The term "Oryctology," having essentially the same meaning, was also used for this branch of study. For a long period, too, the termination *ites* (λίθος, a stone) was applied to fossils to distinguish them from the corresponding living forms; as, for instance, *Ostracites*, used by Pliny. At a later date, the general name "figured stones" (*Lapides figurati*) was extensively used; and less frequently, "deluge stones" (*Lapides diluviani*). The term "organised fossils" was used to distinguish fossils from minerals, when the real difference became known, although the name *Reliquiæ* was sometimes employed. The term "petrifactions" (*Petrificata*) was defined by John Gesner in his work on fossils in 1758, and was afterwards extensively used. Palæontology is comparatively a modern term, having come into use only within the last half century. It was introduced about 1830, and soon was generally adopted in France and England; but in Germany it met with less favour, though used to some extent.

It would be interesting, too, did time permit, to trace the various opinions and superstitions, held at different times, in regard to some of the more common fossils, for example, the ammonite, or the belemnite. Of their supposed celestial origin; of their use as medicine by the ancients, and in the East to-day; of their marvellous power as charms, among the Romans, and still among the American Indians. It would be instructive, also, to compare the various views expressed by students in science, concerning some of the stranger extinct forms, for instance, the nummulites, among protozoa; the rudistes, among molluscs; or the mosasaurus, among reptiles. Dissimilar as such views were, they indicate in many cases gropings after truth—natural steps in the increase of knowledge.

The third period in the history of palæontology, which, as I have said, began with Cuvier and Lamarck at the beginning of the present century, forms a natural epoch extending through six decades. The definite characteristics of this period, as stated, were dominant during all this time, and the progress of palæontology was commensurate with that of intelligence and culture.

For the first half of this period, the marvellous discoveries in the Paris Basin excited astonishment, and absorbed attention; but the real significance and value of the facts made known by Cuvier, Lamarck, and William Smith, were not appreciated. There was still a strong tendency to regard fossils merely as interesting objects of natural history, as in the previous period, and not as the key to profounder problems in the earth's history. Many prominent geologists were still endeavouring to identify formations in different countries by their mineral characters, rather than by the fossils imbedded in them. Such names as "old red sandstone," and "new red sandstone," were given in accordance with this opinion. Humboldt, for example, attempted to compare the formations of South America and Europe by their mineral features, and doubted the value of fossils for this purpose. In 1823 he wrote as follows: "Are we justified in concluding that all formations are characterised by particular species? that the fossil shells of the chalk, the Muschelkalk, the Jura limestone, and the Alpine limestones, are all different? I think this would be pushing the induction much too far."[1] Jameson still thought minerals more important than fossils for characterising formations; while Bakewell, later yet, defines palæontology as comprising "fossil zoology and fossil botany, a knowledge of which may appear to the student as having little connection with geology."

During the later half of the third period, greater progress was made, and before its close geology was thoroughly established as a science. Let us consider for a moment what had really been accomplished up to this time.

It had now been proved beyond question that portions at least of the earth's surface had been covered many times by the sea, with alternations of fresh water and of land; that the strata thus deposited were formed in succession, the lowest of the series being the oldest; that a distinct succession of animals and plants had inhabited the earth during the different geological periods; and that the order of succession found in one part of the earth was essentially the same in all. More than 30,000 new species of extinct animals and plants had now been described. It had been found, too, that from the oldest formations to the most recent, there had been an advance in the grade of life, both animal and vegetable, the oldest forms being among the simplest, and the higher forms successively making their appearance.

It had now become clearly evident, moreover, that the fossils from the older formations were all extinct species, and that only in the most recent deposits were there remains of forms still living. The equally important fact had been established, that in several groups of both animals and plants, the extinct forms were vastly more numerous than the living; while several orders of fossil animals had no representatives in modern times. Human remains had been found mingled with those of extinct animals, but the association was regarded as an accidental one by the authorities in science; and the very recent appearance of man on the earth was not seriously questioned. Another important conclusion reached, mainly through the labours of Lyell was, that the earth had not been subjected in the past to sudden and violent revolutions; but the changes wrought had been gradual, differing in no respect from those still in progress. Strangely enough, the corollary to this proposition, that life, too, had been continuous on the earth, formed at that date no part of the common stock of knowledge.

In the physical world, the great law of "correlation of forces" had been announced, and widely accepted; but in the organic world, the dogma of the miraculous creation of each separate species still held sway, almost as completely as when Linnæus declared: "There are as many different species as there were different forms created in the beginning by the

[1] "Essai géognistique sur le Gisement des Roches," p. 41.

Infinite Being." But the dawn of a new era was already breaking, and the third period of palæontology we may consider now at an end.

Just twenty years ago, science had reached a point when the belief in "special creations" was undermined by well-established facts, slowly accumulated. The time was ripe. Many naturalists were working at the problem, convinced that evolution was the key to the present and the past. But how had Nature brought this change about? While others pondered Darwin spoke the magic word—"Natural Selection," and a new epoch in science began.

The fourth period in the history of palæontology dates from this time, and is the period of to-day. One of the main characteristics of this epoch is the belief that *all life, living and extinct, has been evolved from simple forms*. Another prominent feature is the accepted fact of *the great antiquity of the human race*. These are quite sufficient to distinguish this period sharply from those that preceded it.

The publication of Charles Darwin's work on the "Origin of Species," November, 1859, at once aroused attention, and started a revolution which has already in the short space of two decades changed the whole course of scientific thought. The theory of "Natural Selection," or, as Spencer has happily termed it, the "Survival of the Fittest," had been worked out independently by Wallace, who justly shares the honour of the discovery. We have seen that the theory of evolution was proposed and advocated by Lamarck, but he was before his time. The anonymous author of the "Vestiges of Creation," which appeared in 1844, advocated a somewhat similar theory, which attracted much attention, but the belief that species were immutable was not sensibly affected until Darwin's work appeared.

The difference between Lamarck and Darwin is essentially this: Lamarck proposed the theory of evolution; Darwin changed this into a doctrine, which is now guiding the investigation in all departments of biology. Lamarck failed to realise the importance of time, and the inter-action of life on life. Darwin, by combining these influences with those also suggested by Lamarck, has shown *how* the existing forms on the earth may have been derived from those of the past.

This revolution has influenced palæontology as extensively as any other department of science, and hence the new period we are discussing. In the last epoch species were represented independently, by parallel lines; in the present period they are indicated by dependent, branching lines. The former was the analytic, the latter is the synthetic, period. To-day the animals and plants now living are believed to be genetically connected with those of the distant past, and the palæontologist no longer deems species of the first importance, but seeks for relationships and genealogies, connecting the distant past with the present. Working in this spirit, and with such a method, the advance during the last decade has been great, and is an earnest of what is yet to come.

The progress of palæontology in Great Britain during the present period has been great, and the general interest in the science much extended. The views of Darwin soon found acceptance here. Next to his discovery of "Natural Selection," Darwin was fortunate in having so able and bold an expounder as Huxley, who was one of the first to adopt his theory and give it a vigorous support. Huxley's masterly researches have been of great benefit to all departments of biology, and his contributions to palæontology are invaluable. Among the latter his original investigations on the relations of birds and reptiles are especially noteworthy. His various memoirs on extinct reptiles, amphibians, and fishes, belong to the permanent literature of the subject. The important researches of Owen on the fossil vertebrates have been continued to the present time. He has added largely to his previous publications on the British fossil reptiles, birds, and mammals, the extinct reptiles of South Africa, and the post-tertiary birds of New Zealand. His description of the *Archæopteryx*, near the beginning of the period was a most welcome contribution.

The investigations of Egerton on fossil fishes have likewise been continued with important results. Busk, Dawkins, Flower, and Sanford have made valuable contributions to the history of fossil mammals. Bell, Günther, Hulke, Lankester, Powrie, Miall, and Seely, have made notable additions to our knowledge of reptiles, amphibians, and fishes. Among invertebrates the crustacea have been especially studied by Jones, Salter, and Woodward. Davidson, Etheridge, Lycett, Morris, Phillips, Wood, and Wright have continued their researches on molluscs; Duncan, Nicholson, and others, have investigated the extinct corals, and Binney and Carruthers the fossil plants. Numerous other important contributions have been made in Great Britain to the science during the present period.

On the Continent the advance in palæontology has, during the last two decades, been equally great. In France Gervais continued his memoirs on extinct vertebrates nearly to the present date; while Gaudry has published several volumes on the subject that are models for all students of the science. His work on the fossil animals of Greece is a perfect monograph of its kind, and his later publications are all of importance. Lartet's various works are of permanent value, and his application of palæontology to archæology brought notable results. The volume of Alphonse Milne-Edwards on fossil crustacea was a fit supplement to Brongniart and Desmarest's well-known work, while his grand memoir on fossil birds deserves to rank with the classic volumes of Cuvier. Duvernoy, Filhol, Hébert, Sauvage, and others, have also published interesting results on fossil vertebrates.

Van Beneden's researches on the fossil vertebrates of Belgium have produced results of great value. Pictet, Rütimeyer, and Wedersheim in Switzerland, Bianconi, Forsyth-Major, and Sismonda in Italy, and Nodot in Spain, have likewise published important memoirs. The extinct vertebrates have been studied in Germany by von Meyer, Carus, Fraas, Giebel, Haeckel, Haase, Hensel, Kayser, Kner, Ludwig, Peters, Portis, Maack, Salenka, Zittel, and many others; in Denmark by Reinhardt; and in Russia by Brandt and Kowalevsky.

The fossil invertebrates have been investigated with care by D'Archiac, D'Orbigny, Bayle, Fromentel, Oustalet, and others in France; Desor, Loriol, and Roux in Switzerland; Cappellini, Massalongo, Michellotti, Meneghini, and Sismonda in Italy; Barrande, Benecke, Beyrich, Dames, Dorn, Ehlers, Geinitz, Giebel, Gümbel, Feistmantel, Hagen, von Hauer, von Heyden, von Fritsch, Laube, Oppel, Quenstedt, Roemer, Schlüter, Suess, Speyer, and Zittel in Germany, and Winkler in Holland. The fossil plants have been studied in these countries by Massalongo, Saporta, Zigno, Fiedler, Goldenberg, Gehler, Heer, Goeppert, Ludwig, Schimper, Schenk, and many others.

Among the recent researches in palæontology in other regions may be mentioned those of Blanford, Feistmantel, Lydekker, and Stoliczka; in India, Haast and Hector in New Zealand, and Krefft and McCoy in Australia; all of whom have published valuable results.

Of the progress of palæontology in America I have thus far said nothing, and I need now say but little, as many of you are doubtless familiar with its main features. During the first and second periods in the history of palæontology, as I have defined them, America, for most excellent reasons, took no part. In the present century, during the third period, appear the names of Bigsby, Green, Morton, Mitchell, Rafinesque, Say, and Troost, all of whom deserve mention. More recently, the researches of Conrad, Dana, Deane, De Kay, Emmons, Gibbes, Hitchcock, Holmes, Lea, Owen, Redfield, Rogers, Shumard, Swallow, and many others, have enlarged our knowledge of the fossils of this country.

The contributions of James Hall to the invertebrate palæontology of this country form the basis of our present knowledge of the subject. The extensive labours of Meek in the same department are likewise entitled to great credit, and will form an important chapter in the history of the science. The memoirs of Billings, Gabb, Scudder, White, and Whitfield are numerous and important, and the publications of Derby, Hartt, James, Miller, Shaler, Rathburn, and Winchell, are also of value. To Dawson, Lesquereux, and Newberry, we mainly owe our present knowledge of the fossil plants of this country.

The foundation of our vertebrate palæontology was laid by Leidy, whose contributions have enriched nearly every department of the subject. The numerous publications of Cope are well known. Agassiz, Allen, Baird, Dawson, Deane, De Kay, Emmons, Gibbes, Harlan, Hitchcock, Jefferson, Lea, Le Conte, Newberry, Redfield, St. John, Warren, Whitney, Worthen, Wyman, and others, have all added to our knowledge of American fossil vertebrates. The chief results in this department of our subject, I have already laid before you on a previous occasion, and hence need not dwell upon them here.

In this rapid sketch of the history of palæontology, I have

thought it best to speak of the earlier periods more in detail, as they are less generally known, and especially as they indicate the growth of the science, and the obstacles it had to surmount. With the present work in palæontology, moreover, you are all more or less familiar, as the results are now part of the current literature. To assign every important discovery to its author would have led me far beyond my present plan. I have only endeavoured to indicate the growth of the science by citing the more prominent works that mark its progress, or illustrate the prevailing opinions and state of knowledge at the time they were written.

In considering what has been accomplished, directly or indirectly, it is well to bear in mind that without palæontology there would have been no science of geology. The latter science originated from the study of fossils, and not the reverse, as generally supposed. Palæontology, therefore, is not a mere branch of geology, but the foundation on which that science mainly rests. This fact is a sufficient excuse, if one were wanting, for noting the early opinions in regard to the changes of the earth's surface, as these changes were first studied to explain the position of fossils. The investigation of the latter first led to theories of the earth's formation, and thus to geology. When speculation replaced observation, fossils were discarded, and for a time the mineral characters of strata were thought to be the key to their position and age. For some time after this, geologists, as we have seen, apologised for using fossils to determine formations, but for the last half century their value for this purpose has been fully recognised.

The services which palæontology has rendered to botany and zoology are less easy to estimate, but are very extensive. The classification of these sciences has been rendered much more complete by the intercalation of many intermediate forms. The probable origin of various living species has been indicated by the genealogies suggested by extinct types; while our knowledge of the geographical distribution of animals and plants at the present day has been greatly improved by the facts brought out in regard to the former distribution of life on the globe.

Among the vast number of new species which have been added are the representatives of a number of new orders entirely unknown among living forms. The distribution of these extinct orders, among the different classes, is interesting, as they are mainly confined to the higher groups. Among the fossil plants, no new orders have yet been found. There are none known among the protozoa or the mollusca. The radiates have been enriched by the extinct orders of Blastoidea, Cystidea, and Edrioasterida; and the crustaceans by the Eurypterida and Trilobita. Among the vertebrates no extinct order of fossil fishes has yet been found; but the amphibians have been enlarged by the important order labyrinthodonta. The greatest additions have been among the Reptiles, where the majority of the orders are extinct. Here we have at the present date the Ichthyosauria, Sauranodontia, Plesiosauria, and Mosasauria among the marine forms; the Pterosauria, including the Pteranodontia, containing the flying forms; and the Dinosauria, including the Sauropoda—the giants among reptiles; likewise the Dicynodontia and probably the Theriodontia, among the terrestrial forms. Although but few fossil birds have been found below the tertiary, we have already among the mesozoic forms three new orders: the Saururæ, represented by *Archæopteryx;* the Odontotormæ, with *Ichthyornis* as the type; and the Odontolcæ, based upon *Hesperornis;* all of these orders being included in the sub-class Odontornithes, or toothed birds. Among Mammals, the new groups regarded as orders are the Toxodontia, and the Dinocerata, among the Ungulates; and the Tillodontia, including strange eocene mammals whose exact affinities are yet to be determined.

Among the important results in vertebrate palæontology are the genealogies, made out with considerable probability, for various existing animals. Many of the larger mammals have been traced back through allied forms in a closely-connected series to early tertiary times. In several cases the series are so complete that there can be little doubt that the line of descent has been established. The evolution of the horse, for example, is to-day demonstrated by the specimens now known. The demonstration in one case stands for all. The evidence in favour of the genealogy of the horse now rests on the same foundation as the proof that any fossil bone once formed part of the skeleton of a living animal. A special creation of a single bone is as probable as the special creation of a single species. The method of the palæontologist in the investigation of the one is the method for the other. The only choice lies between natural derivation and supernatural creation.

For such reasons it is now regarded among the active workers in science as a waste of time to discuss the truth of evolution. The battle on this point has been fought and won.

The geographical distribution of animals and plants, as well as their migrations, have received much new light from palæontology. The fossils found in some natural divisions of the earth are related so closely to the forms now living there that a genetic connection between them can hardly be doubted. The extinct marsupials of Australia and the edentates of South America, are well-known examples. The pliocene hippopotami of Asia and the South of Europe point directly to migrations from Africa. Other similar examples are numerous. The fossil plants of the Arctic region prove the existence of a climate there far milder than at present, and recent researches at least render more probable the suggestion, made long ago by Buffon, in his "Epochs of Nature," that life began in the Polar regions, and by successive migrations from them the continents were peopled.

The great services which comparative anatomy rendered to palæontology at the hands of Cuvier, Agassiz, Owen, and others, have been amply repaid. The solution of some of the most difficult problems in anatomy has received scarcely less aid from the extinct forms discovered than from embryology, and the two lines of research supplement each other. Our present knowledge of the vertebrate skull, the limb-arches, and the limbs, has been much enlarged by researches in palæontology. On the other hand, the recent labours of Gegenbaur, Huxley, Parker, Balfour, and Thacher, will make clear many obscure points in ancient life.

One of the important results of recent palæontological research is the law of brain-growth, found to exist among extinct mammals, and to some extent in other vertebrates. According to this law, as I have briefly stated it elsewhere, "all tertiary mammals had small brains. There was, also, a gradual increase in the size of the brain during this period. This increase was confined mainly to the cerebral hemispheres, or higher portions of the brain. In some groups the convolutions of the brain have gradually become more complicated. In some the cerebellum and the olfactory lobes have even diminished in size." More recent researches render it probable that the same general law of brain-growth holds good for birds and reptiles from the mesozoic to the present time. The cretaceous birds, that have been investigated with reference to this point, had brains only about one-third as large in proportion as those nearest allied among living species. The dinosaurs from our Western Jurassic follow the same law, and had brain cavities vastly smaller than any existing reptiles. Many other facts point in the same direction, and indicate that the general law will hold good for all extinct vertebrates.

Palæontology has rendered great service to the more recent science of archæology. At the beginning of the present period a re-examination of the evidence in regard to the antiquity of the human race was going on, and important results were soon attained. Evidence in favour of the presence of man on the earth at a period far earlier than the accepted chronology of six thousand years would imply, had been gradually accumulating, but had been rejected from time to time by the highest authorities. In 1823 Cuvier, Brongniart, and Buckland, and later, Lyell, refused to admit that human relics, and the bones of extinct animals found with them, were of the same geological age, although experienced geologists, such as Boué and others, had been convinced by collecting them. Christol, Serres, and Tournal, in France, and Schmerling in Belgium, had found human remains in caves, associated closely with those of various extinct mammals, and other similar facts were on record.

Boucher de Perthes, in 1841, began to collect stone implements in the gravels of the valley of the Somme, and in 1847 published the first volume of his "Antiquités celtiques." In this work he described the specimens he had found and asserted their great antiquity. The facts as presented, however, were not generally accepted. Twelve years later Falconer, Evans, and Prestwich examined the same localities with care, became convinced, and the results were published in 1859 and 1860.

About the same time Gandry, Hébert, and Desnoyers also explored the same valley, and announced that the stone implements there were as ancient as the mammoth and rhinoceros found with them. Explorations in the Swiss lakes and in the Danish shell heaps added new testimony bearing in the same direction. In 1863 appeared Lyell's work on the "Geological Evidences of the Antiquity of Man," in which facts were brought together from various parts of the world, proving beyond question the great age of the human race.

The additional proof since brought to light has been extensive, and is still rapidly increasing. The quaternary age of man is now generally accepted. Attempts have recently been made to approximate in years the time of man's first appearance on the earth. One high authority has estimated the antiquity of man merely to the last glacial epoch of Europe as 250,000 years, and those best qualified to judge would, I think, regard this as a fair estimate.

Important evidence has likewise been adduced of man's existence in the tertiary, both in Europe and America. The evidence to-day is in favour of the presence of man in the pliocene of this country. The proof offered on this point by Prof. J. D. Whitney, in his recent work,[1] is so strong, and his careful, conscientious method of investigation so well known, that his conclusions seem inevitable. Whether the pliocene strata he has explored so fully on the Pacific coast corresponds strictly with the deposits which bear this name in Europe, may be a question requiring further consideration. At present the known facts indicate that the American beds containing human remains, and works of man, are at least as old as the pliocene of Europe. The existence of man in the tertiary period seems now fairly established.

In looking back over the history of palæontology, much seems to have been accomplished, and yet the work has but just begun. A small fraction only of the earth's surface has been examined, and two large continents are waiting to be explored. The "imperfection of the geological record," so often cited by friends and foes, still remains, although much improved, but the future is full of promise. In filling out this record America, I believe, will do her full share, and thus aid in the solution of the great problems now before us.

I have endeavoured to define clearly the different periods in the history of palæontology. If I may venture, in conclusion, to characterise the present period in all departments of science, its main feature would be a *belief in universal laws*. The reign of Law, first recognised in the physical world, has now been extended to Life as well. In return, Life has given to inanimate nature the key to her profounder mysteries—Evolution, which embraces the universe.

What is to be the main characteristic of the next period? No one now can tell. But if we are permitted to continue in imagination the rapidly converging lines of research pursued today, they seem to meet at the point where organic and inorganic nature become one. That this point will yet be reached I cannot doubt.

THE EFFECT OF SUNLIGHT UPON HYDROGEN PEROXIDE[2]

WE believe that it has not been previously observed that hydrogen peroxide in solution is decomposed by sunlight; it may therefore be of interest to state that during the continuation of our investigations on the chemical effects of sunlight, we found that (1) after about ten months insolation aqueous solutions, containing about 8 per cent. of hydrogen peroxide, were entirely destroyed, and that (2) corresponding solutions shielded from light proved much more stable than is commonly supposed. We are inclined to think that the insolation needs to be prolonged—although we have made no direct observations on this point—because some of the solution, exposed in a thick glass bottle standing in a window, was found to be still of considerable strength after a period sufficient to destroy a corresponding sample in a thin test-tube.

We have elsewhere[3] shown that oxalic acid is destroyed by sunlight by the oxidation of its hydrogen by *external* oxygen, thus:—

$$C_2O_4H_2 + O - = 2CO_2 + H_2O.$$

[1] "Auriferous Gravels of the Sierra Nevada of California." 1879.
[2] By Arthur Downes, M.D., and T. P. Blunt, M.A.
[3] *Proc.* Roy. Soc., vol. xxviii. p. 204.

There is not, we believe, any analogy whatever between that case and this. There we have the "chlorons radicle" C_2O_4 in combination with the basylous H_2, the latter being seized upon by the superior affinity of the external oxygen stimulated under sunlight. Here we may regard the hydrogen peroxide as made up of two atomic groupings of the chlorous radicle HO and, if the theory we suggest be correct, the decomposition in this case is brought about by the dissociation of these radicles. We believe that the tendency of sunlight is to dissociate (or "weaken the internal bonds" between) what we have termed "chlorous radicles," whether these be simple, as oxygen or chlorine, or compound as HO, and thus to promote their combining energy, or to bring about a more stable arrangement of their constituent atoms.

THE FRENCH ASSOCIATION

AMONG the addresses at the Montpellier meeting we must notice that of Col. Laussedat, on geography considered from the point of view of protecting national independence, and on the creation of a French Signal Corps, in imitation of the well-known United States organisation.

M. Broca arrived just in time to give information relating to the Congress of Anthropology which had taken place in Moscow, and at which he had assisted with eleven other French *savants*. The expenses of the journey were paid by the Moscow Anthropological Society and by private donations. The session, the proceedings of which will appear in the *Journal des Missions du Ministère de l'Instruction publique*, and were reported in several French papers, lasted twelve days. M. Quatrefages was considered the head of the party, and gave in their name the loyal Russian toasts in the Kremlin. It is the first time that French *savants* have been entertained in this historical edifice, which was burnt to thwart the designs of the great French conqueror.

M. Chauveau, the Director of the Veterinary School of Lyons, was elected the President for the exceptional meeting at Algiers. The Secretary appointed for this occasion was M. Maunoir, the Permanent Secretary of the Geographical Society of Paris. This election shows that geographical questions will take a prominent place in April, 1881, at the capital of the French colony in North Africa. Much will be heard of the Transaharian, and it is expected that work will be begun on a large scale in the desert on this occasion. The nomination of M. Chauveau took place against the wish of the Council of the Society, who had presented as their candidate M. Baillon, the anthor of the Botanical Dictionary. The appointment of M. Chauvean is considered as a protest against the Haeckelian tendencies of the committee and a revival of the old Montpellier vitalist opinions. At all events, it has created some sensation.

The meeting for 1880 will take place in Rheims, as usual in the month of August, and is sure to be attended by a number of foreign visitors. Great preparations are being made by the local committee to give to the guests an unprecedented reception and to impress upon them a great idea of the peculiarities of the city.

SPECTROSCOPICAL OBSERVATIONS OF SHOOTING STARS

PROF. VON KONKOLY, of the Astro-physical Observatory of O-Gyalla (Hungary), contributes an interesting paper on the spectra of shooting stars to a recent number of the *Astronomische Nachrichten*, from which we note the following data:—On July 26 and 28, and again on August 12 and 13, the Professor had the opportunity of observing some bright shooting stars spectroscopically, and, with a few exceptions, he arrived at the result that the heads of shooting stars give a continuous spectrum generally, upon which very often the bright sodium line appears projected. Since this, however, is not always the case, Prof. von Konkoly inclines to the belief that considerable differences of elevation exist amongst shooting stars, and that those which do not show the sodium line are travelling in very much higher regions than those which do show the line in question, since he looks upon the sodium line as not belonging to the shooting star itself, but as resulting from the atmospheric air which the meteorite condenses and renders incandescent. It is evident that in very high regions there must be very much less (if any) chloride of sodium suspended in the atmosphere than in lower strata.

In the spectra of some of the July meteors a red line was also observed, but a blue one was looked for in vain; yet the professor would not deny that the red line in question may have been a potassium line and that the blue Kβ was simply overlooked on account of its extreme weakness.

The meteors observed on August 12 and 13 resembled those observed in July in almost all details. Thus a yellow meteor of the first magnitude was observed, which evidently originated from the Perseus radiating point. In the spectrum of the head of this meteor, besides the bright sodium line, the lithium lines were distinctly visible; three seconds later another meteor of about the second magnitude passed through the field of the spectroscope in a direction exactly parallel to the former one, and the spectrum of both head and tail in this case was simply a tolerably bright continuous one, without any appearance even of the bright sodium line.

At 10h. 46m. 10s. Prof. von Konkoly saw a magnificent meteor in the north-eastern sky; it moved very slowly, its colour was emerald green, its brilliancy equal to that of Jupiter; he at once directed his spectroscope towards it. At the first appearance the head showed the sodium line only, but soon a number of lines were seen in the green and blue, of which one was recognised as a magnesium line, while others were suspected to be copper lines. There were also two faint lines visible in the red. On August 14 several other meteors were observed with the spectroscope, but only one was seen in the spectrum of which a faint red line appeared besides the sodium line; of these meteors several were of the first magnitude and did *not* show the sodium line; other ones of a lesser magnitude showed the sodium line very brightly besides a continuous spectrum more or less brilliant.

At the same observatory two stationary meteors were observed: one by Capt. von Reviczky on July 26, at 11h. 48m. O-Gyalla mean time (position: 2h. 0m. R.A and 29° 0′ decl. N., magnitude 3); the other by Herr J. Rosenzweig, the assistant at the observatory, on August 11 at 9h. 47m. 1s. O-Gyalla mean time (position: 2h. 14m. R.A. and 55° 18′ decl. N., magnitude 3).

The total numbers of shooting stars of the two showers referred to, which were observed at O-Gyalla were as follows:—

		Meteors.
July	25	72
,,	26	87
,,	28	26
August	11	110
,,	12	50
,,	13	50
,,	14	35

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Calendar of the Yorkshire College for the sixth session (1879–80) has just been published. It appears this year for the first time in stiff covers, and with the prospectus of the Leeds School of Medicine makes a book of 204 pages. The growth in the size of the calendar corresponds with the extension of the College curriculum, for several new classes are announced for the approaching session, which begins on October 7 next. Mr. W. Philp, M.A., B.Sc., has been appointed mathematical and classical tutor, and the College authorities have thus been able to arrange for a systematic oversight of students who are preparing for the examinations of the University of London. The Natural Philosophy lectures are now arranged in two courses. The first year's course comprises the requirements for London Matriculation, viz., Mechanics, Optics, and Heat; the second year courses, those for the B.A. and other degrees, viz., Mechanics, Heat, Acoustics, Light, Electricity, and Magnetism. The Chemistry Classes remain the same as last year. Students have the privilege of pursuing a course of practical chemistry in the laboratory at times convenient to themselves, and for such periods as they are able to devote to that study. The Saturday morning chemistry lecture and practical class are to be continued, schools and teachers having largely availed themselves of this opportunity in past sessions. The arrangements and the classes in Mathematics, Geology and Mining, Biology, Zoology and Comparative Anatomy, Botany, Civil and Mechanical Engineering, Latin, Greek, French, German, Oriental Languages, Coal Mining, and Textile Industries remain for the most part unaltered, but the important subject of Mental and Moral Science has been added, Logic being taken in the earlier part of the session, and Psychology in the later part. The classes in Modern Literature and History have been multiplied and rearranged, so as to give a complete course in Literature and History for the London Matriculation and 1st B.A. examinations, a complete course on the special subjects in Literature and History for the Cambridge Higher Local examination, and a course of History for the Cambridge Senior and Junior Local examinations, besides other classes for students not reading for examinations. The fees in some of these classes are fixed on a very low scale, to meet the requirements of teachers and others preparing for the University Local examination. This is an endeavour to extend the usefulness of the college, which will, no doubt, be warmly appreciated by the large class of persons directly affected by it. The department of Textile Industries continues to receive the attention it deserves, and although the students cannot be located in their new premises at Beech Grove at the opening of the Session, as had been hoped, their interests have been amply provided for in the temporary class rooms and in the weaving annexe in Cookridge Street. The practical value of the instruction given by Mr. Beaumont is widely recognised, and we observe that the committee are doing what they can to impress on the students in this department the value of a thorough acquaintance with the most important branches of textile manufacture. Arrangements for the establishment of a school of dyeing are in an advanced state. In the evening classes there are to be courses of lectures on Mechanics, Chemistry, Geology, Biology, Botany, and Engineering, and classes in Latin, Greek, English Grammar, and Textile Industries. A somewhat bold experiment is to be tried by the introduction of two short courses of lectures of a more popular character than the ordinary evening class lectures.

MR. T. JEFFERY PARKER, B.Sc., Demonstrator of Biology in the Royal School of Mines, has been appointed to the new lectureship on Biology at Bedford College, York Place, Portman Square.

THE City and Guilds of London Institute for the Advancement of Technical Education have issued a detailed programme of subjects in which examinations will be held in 1880. It embraces a great variety of subjects, in the more scientific of which some eminent men of science have been obtained as examiners. Any one interested in the matter will, no doubt, obtain a copy of the programme by applying to the Secretary, Mercers' Hall, E.C.

M. JULES FERRY has published a regulation tending to diminish the importance given to the *Compositions des Prix* in the several French educational establishments and to shorten the time assigned to the young competitors for writing their essays. Much dissatisfaction is felt by teachers and the best pupils at Government trying to repress the sense of emulation. It is expected that petitions will be sent to the French Parliament protesting against the supposed retrograde step taken by the Administration.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 7.—In the opening paper, on electric limiting layers, Prof. Helmholtz studies the case where there is a difference of potential at the limiting surface of two different bodies, giving, along this surface, what he calls an "electric double layer," as, *e.g.*, when a zinc and a copper plate, in metallic connection, are approximated to each other. He groups together, in this relation, the phenomena of metallic electrodes in an undecomposed electrolyte, frictional electricity, flow of liquids on solids, and applies an explanation of the last-named case to various recorded phenomena of electrical action in liquids.—Herr Beetz describes a new investigation of the heat-conducting power of various liquids. The differences in this property, according as the temperatures were above or below 20°, are made manifest, and the discrepancies of previous data in part explained. The phenomena of heat conduction in liquids are considered to depend on mechanical molecular processes, or friction phenomena, as Kohlrausch has shown to be the case with electrolytic conduction.—A paper by Herr Barus treats of the thermo-electric position and electric conductivity of steel in its relation to hardening. He shows that the steel bars examined fell into two classes, those of the one class (the harder) being electro-negative to copper, those of the other (the softer) electro-positive. A simple method of classing steel is deduced from this. —In a second communication on experimental determination of

the velocity of light in crystals, Herr Kohlrausch finds that also for oblique sections of optically biaxial crystal Fresnel's theory of light-motion in crystals is fully in harmony with observation.—Remaining papers:—On elastic reaction in longitudinal extension, by Herr Neesen.—Researches on the elementary law of hydro-diffusion, by Herr H. F. Weber.—On the magnetic behaviour of pulverised iron, by Herr V. Waltenhofen.—On extra currents in conductors of various thickness, by Herr Herwig.

No. 8.—The transpiration of vapours is here the subject of a paper by Herr L. Meyer, whose method of experiment was to heat the substance under determinate regulated pressure to boiling, and let the vapour play over the capillary tube, and partly stream through into a vacuous cooled space, where it was condensed and after some time measured as liquid. Herr Meyer finds, *inter alia*, that the friction of vapour increases with rising temperature and faster than that of gases; further, the molecular volume in the vapour state, as in gases, seems to be greater at a low than at a high temperature.—In a lengthy (third) paper on the electric conduction of gases, Herr Hittorf describes many interesting effects obtained with a Bunsen battery of 1,600 elements. This gave him within wide limits, a constant glow discharge. He has no doubt that the character of phosphorescent light is to be attributed to the spectra of the first order. All non-metallic gases, whether elementary or compound, can probably be thrown into the phosphorescent state by the electric current giving such spectra. The electric behaviour of flame gases is different from that of the same gases at the same temperature, when not involved in the chemical process. In the glow-discharge, the author considers, there is not a transference of gas particles; and the propagation of the current everywhere (including the dark layers and space) is effected by a different process. The molecules of a gas have a real conductivity, like the particles of metals and electrolytes, inasmuch as they discharge in every direction the least difference of tension. The author supports, by experimental evidence, Faraday's views of the nature of discharge.—A peculiar spark discharge at the so-called negative pole of an induction apparatus is studied by Herr Hankel; there being a blunt point at the negative pole, and a plate or large ball at the positive, positive electricity may (by reason of oscillations in the coil), spring over from the point to the plate or ball in long sparks.—Remaining papers: Researches on the elementary law of hydro-diffusion (continued), by Herr H. F. Weber.—On the change of phase of light by reflection, by Herr Glan.—On the density of the luminous ether, by the same (the lower limiting value he assigns is 7,416 times that of Thomson).—The law of dispersion, by Herr Kettler.—The oxygen spectrum, by Dr. Schuster.—Generalisation of a theorem of attraction, by Herr Schalbach.—Contributions to a history of natural sciences among the Arabs, by Herr Wiedemann.

THE *Sitzungsberichte der königl. boehmischen Gesellschaft der Wissenschaften in Prag* (Jahrg. 1877 and 1878) contain the following papers of interest:—On the prehistoric vertebrate fauna of Bohemia, by Prof. Anton Fric.—On the recent history of botany, by Herr Ladislav Celakovsky.—On a new spectrometrical method, by Prof. K. V. Zenger.—On the bases of iconognosy, by Prof. F. Tilser.—On the gas-coal fauna of Zabor near Schlan, Kroucova near Renc, and Tremosna near Pilsen, and on the sphærosiderite balls of Zilov, by Dr. Anton Fric.—On the calculation of aplanatic katadioptric object glasses, by Prof. K. V. Zenger.—Several mathematical papers by Prof. Emil Weyr.—On some new microscopical and chemical methods for the determination of certain minerals, particularly of felspars, if they occur in very minute fragments or sections, and on the phenomena apparent in etched, natural, and ground surfaces of apatite, by Prof. Dr. Emanuel Boricky.—On the discovery of *Placoparia Zippei*, Corda, at the foot of the Lorenzi hill at Smichov near Prague, by Prof. Josef Korensky.—On the discovery of a tooth of *Hyæna spelæa* in the diluvial deposits of Hlubocerp.—Several mathematical papers by Prof. Franz Studnicka, Karl Zahradnik, and Josef Solin.—Critical remarks on Wigand's "Darwinismus" concerning the differences of Darwin's doctrine of descent and the "Genealogie der Urzellen," by Prof. Lad. Celakovsky.—On the distribution of vertebrates in ancient and recent geological periods, by Dr. Johann Palacky.—On species, forms, and hybrids of *Pilosella*, a subgenus of *Hieracium*, by Dr. Knaf.—On a new solar eye-piece and on a new position micrometer, by Prof. K. V. Zenger.—On the triple change of generation of plants, by Prof. Lad. Celakovsky.—On a new saurian from the limestone of the Permian formation of Braunau (Bohemia), by Prof. Anton Fric.—On the results of ombrometrical measurements made in Bohemia, particularly with reference to the meteorological net, by Prof. Fr. Studnicka.—On the international horticultural exhibition of Amsterdam, by Prof. Dr. M. Willkomm.—On a theorem of the potential theory, and on steel magnets, by Prof. A. von Waltenhofen.—On the south-eastern border of the European flora, by Dr. Johann Palacky.—A series of mathematical papers, by Franz Zrzavy, Gustav Schmidt, S. Günther, Wilhelm Matzka, Gust. Gruss, Gottlieb Becka, and S. Kantor.—New researches on compound fluorides by Prof. Fr. Stolba.—On the anatomy and systematics of *Enchytridæ*, by Dr. F. Vejdorsky.—On the porphyries of the Libcicer rock, by Prof. E. Boricky.—Analysis of the Moldau water, by Prof. A. Belohoubek.—On the theory of twin crystals, by Prof. J. Krejci.—On dioxalate of rubidium and its preparation from rubidium alum, by Prof. F. Stolba.—On the survey of the iron-ore mountains in the Chrudim and Caslau districts in Bohemia, by Prof. J. Krejci.—On the relation existing between certain fossil floræ and land-faunæ, and between them and the simultaneous marine faunæ, in India, Africa, and Australia, by Dr. Otakar Feistmantel.—On the variability of *Carabus Scheidleri*. Fabricius, by Jos. Korensky.—On some hydrometrical researches and apparatus, by Prof. R. A. Harlacher.—On a peculiar formation of loops in the cerebral and spinal blood vessels of saurians, by Dr. Josef Schoebel.—On some new vegetable bastards in the Bohemian flora, by L. Celakovsky.—On two new Epilobiæ, bastards in the Bohemian flora, by K. Knaf.—On the capillaries in the mucous membranes of the throat of naked amphibia, with report on a new method of performing injections, by Jos. Schöbl.—On the combination of chlorine with cymol at boiling heat, by B. Raymann.—On the blood vessels of the eyes of cephalopoda, by Jos. Schöbl.—On the origin and period of storms, by K. W. Zenger.—On the deposits of iron ores in the Silurian formation of Bohemia, by K. Feistmantel.—On a new quercitrine sugar, by K. Kruis.—On the travelling routes of migratory birds in Asia, by Joh. Palacky.—Results of the analysis of the Sazava water, by A. Belohoubek.—On the conglomerates of the so-called iron-ore mountains, by Joh. Krejci.—On the Bohemian tertiary flora, by the same.—On the elevation of Carlsbad and its surroundings above the sea level, by K. Koristka.—On the results of some experiments made with a view of growing plants in artificial soils and extending over two years, by F. Farsky.—On some compounds obtained from cholesterine, by R. Preis and B. Raymann.—On the action of iodine upon aromatic compounds, by the same.—On orthobromo-benzoaldehyde, by the same.—On the action of fluoride of silicon upon organic hydroxyl compounds, by the same.—On two sulphosalts of chromium, by the same.—Observations on the reduction formulæ, converting Miller's symbols of the isoclinic system into Naumann's symbols of the hexagonal system, by J. Krejci.—On the employment of oxalate of lead for determining the tenor of Chamæleon solution, by F. Stolba.—On the employment of glass tubes for decomposing steam by means of red-hot iron, by the same.—On the Moravian lepidolite, by the same.—On the separation of cæsium and other alums by means of crystalisation, by the same.—On the preparation of compounds of didymium and lanthanum free from cerium, by the same.

THE *Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg* (tome xxv., No. 4) contains the following papers of importance:—Observation of the passage of Mercury across the sun's disk on May 6, 1878, by A. Sawitsch.—Histological researches on the smaller brain of *Petromyzon fluviatilis*, by A. Jeleneff.—Researches on the Jurassic flora of Russia, by J. Schmalhausen.—On the action of light upon the irritability of the skin of the common frog, by N. Wedensky.—Enumeration of all the Salsolaceæ hitherto found in Mongolia, by Al. Bunge.—General observations on comets, by Th. Bredichin.—Observations of Uranus and Neptune during 1878, by A. Sawitsch.—On the nitro-compounds of toluol, by J. Barsilowsky.—Preliminary communication regarding the appearace of Encke's comet during 1878, by O. Backlund.

THE *Verhandlungen des k.k. geologischen Reichsanstalt* (No. 11, 1879, Vienna) contain the following papers:—On some eruptive rocks from Bosnia, by C. von John.—Researches on the flora of the diatomaceæ-slates of Kutschein, near Bilin, by Johann Sieber.—Notes on some Austrian minerals, by Rudolf Scharizer. The minerals treated of are columbite (tantalite) serpentine, pyrope and pseudomorphous garnet.—On the quaternary formation in Thracia, by A. M. Petz.—On the black porphyry from the

Hallstadt Salt Mountain, by Fr. von Hauer.—Travelling sketches from Bosnia (Travnik), by Dr. Edmund von Mojsisovics.—Another sketch, describing the route from Serajevo to Mostar, is by Dr. A. Bittner; and a third one, on the route from Vares to Zwornik, by Dr. E. Tietze.—On some ammonites from the Carpathian sandstone, by C. M. Paul.

SOCIETIES AND ACADEMIES

Paris

Academy of Sciences, September 15.—M. Daubrée in the chair.—The following papers were read:—On linen cloths dyed bluish black, with the intention of replacing the indigo blue cloths employed in the uniforms of the French army, by M. Chevreul. The blue matter in certain military cloths examined, he is able to say is neither indigotine, nor Prussian blue, nor ultramarine; it may be from aniline, and he is inquiring into this.—Experiments tending to demonstrate the compound nature of phosphorus, by Mr. J. N. Lockyer. Phosphorus heated in a tube with copper gives a gas which shows the spectrum of hydrogen very bright. Phosphorus alone, heated in a Sprengel vacuum tube, gives nothing. Fixed at the negative pole in a similar tube it gives very abundantly a gas which shows the spectrum of hydrogen, but which is not PhH_3. The author also describes experiments with sodium, magnesium, lithium, &c. —Researches on erbine, by M. Lecoq de Boisbaudran. The lines of M. Cleve's holmium are precisely those indicated by M. Soret as characteristic of his earth *X*, and the two substances are evidently identical.—The Minister of Agriculture and Commerce called attention in a letter to the common adulteration of olive oil with oils of different sources, and desired the Academy to indicate a practical means of detecting such fraud, which is very prejudicial to cultivation of the olive.—Observations of Hartwig's comet and Palisa's comet, at the Paris Observatory, by MM. Henry.—Observations of the sun during the second quarter of 1879, by Signor Tacchini. A certain increase in the energy of solar phenomena is perceptible. The hydrogenic protuberances were about equally distributed to the north and to the south (instead of nearly all in the boreal hemisphere, as in the previous quarter). The maximum of frequency is between parallels 30° and 60° in both hemispheres. The preponderance of protuberances in the northern hemisphere seems characteristic of the minimum of solar activity. The maximum of frequency of faculæ is found between parallels 10° and 30° in each hemisphere. The author considers we passed the minimum of solar activity in the beginning of this year. A metallic eruption was observed on June 19.—On the spectra of earths forming part of the group of yttria. A claim of priority with regard to what M. Cleve observed.—Determination of organic nitrogen in natural waters, by M. Pellet. He describes a method which is simpler than that given by M. Lechartier recently.—On the oxidising action of cupric oxide, transformation of acetic acid into glycolic acid, by M. Cazeneuve.—New experiments on the mode of action of chloral regarded as an anæsthetic, by M. Arloing. He concludes that chloral is decomposed into chloroform and alkaline formiates in the blood of animals; that the anæsthetic effects are due to chloroform; and that the alkaline formiates mechanically favour their production by increasing the velocity of the circulation, and thus facilitating the impregnation of the nervous elements by the anæsthetic agent.—M. Wolf's "History of Swiss Geodesy" was presented.

Vienna

Imperial Academy of Sciences, June 19.—The following among other papers, were read:—On the products of decomposition from albuminoids through action of oxymuriatic acid, by Herr Horbaczewski.—Researches on the influence of illumination on penetration of radicles into the ground, by Herr Richter. —On some fresh-water fish of South America, by Dr. Steindachner.—South Japanese annelids, by Dr. Marenzeller.—Observations of refraction on several summits, by Herr von Sterneck.—Fauna of the lias brachiopod line of Sospirolo, near Belluno, by Dr. Uhlig.—Brachiopod fauna of the oolite of Balin, near Krakaw, by Herr Sjaknocha.

July 3.—Prof. Brühl presented the first thirteen parts of his Zootomia of all animal-classes.—On some plane rational curves of the fourth order, by Herr Bobek.—On a direct measurement of the work of induction, and a determination therefrom of the mechanical equivalent of heat, by Prof. von Waltenhofen.—On a peculiar mode of producing the orthogonal hyperboloids, &c., by Herr Ruth.—On the crystallisable constituents of corallin, by Herr Zulkowsky.—On continued fractions, by Prof. Gegenbauer. —On the phosphorescence produced by electric rays, by Herr Goldstein.—On some consequences of the Young-Helmholtz theory, by Herr von Brücke.—Prehistoric settlements and burial places in Krain, by Herr von Hochstetter and Herr Deschmann. —On the radiometer, by Dr. Puluj.

July 10.—Prof. Fric presented a part of his work on fauna of gas-coal and limestone of the Permian formation in Bohemia.—On the behaviour of the bacillus of splenic inflammation under extreme low temperatures, by Prof. Firsch.—Researches on the mechanical behaviour of the acinus glands, by Prof. Stricker and Dr. Spina.—Researches on the structure of the envelope of the cerebrum, by Prof. Stricker and Dr. Unger.—Comparative anatomy of the wood of Ebenaceæ and their allies, by Herr Molisch.—Chemical studies on pemphigus, by Dr. Jarisch.—On glycyrrhizin, by Dr. Habermann.—On some derivatives of dimethylhydrochinon, by Herr Kariot.—On the crystalline structure of apophyllite, by Prof. Rumpf.—On the double formation and optical properties of chabasite, by Herr Becke.—On the camphene of borneol and camphor, by Herr Kachler and Herr Spitzer.—On homocinchonidine, by Herr Skraup.—On chinine, by the same.—On Gay Lussac's hypochloronitric acid, by Herr Goldschmidt.

July 17.—Researches on the liverworts, by Prof. Leitgeb (treating of "Anthoceroteæ").—On the cause of excitation of electricity on contact of heterogeneous metals, by Dr. Exner.—Studies on the development of ferns, by Prof. Leitgeb.—On the distribution of arsenic in the animal organism after ingestion of arsenious acid, by Prof. Ludwig.—Contribution to a knowledge of the action of the *nervus vagus*, by Herr Wagner.—On the constitution of cinchonine and cinchonidine, by Dr. Skraup.—Observations on the differences of the two electric states, by Herr Doubrawa.—On the velocity of propagation of sound in tubes, by Dr. Tumlirz.—On the magnetisation of iron rings, by Prof. v. Ettingshausen. —Contributions to a knowledge of elastic reaction, by Prof. Streintz.—On nephrite and bowenite from New Zealand, by Dr. Berwerth.—On the optical orientation of plagioclase, by Herr Schuster.—On new and rare fishes, by Dr. Steindachner.—On idrialine, by Dr. Goldschmidt.—On nitroprussides, by Herr Bernheimer.—On direct introduction of carboxyl groups into phenols and aromatic acids, by Herr Senhofer and Herr Brunner.—Geological observations in the region of the Thessalian Olympus, by Herr Neumayer.—Ditto in the north-east and south-west of the Peninsula of Chalcidice, by the same, and by Herr Burgerstein.—Geological formation of the Island of Cos, &c., by Herr Neumayer.—New researches on cerebral ganglions and the med. obl., by Dr. Meynert.

CONTENTS

THURSDAY, OCTOBER 2, 1879

THE GREENWICH METEOROLOGICAL OBSERVATIONS

Reduction of Greenwich Meteorological Observations. Barometer, 1854–1873; *Air and Moisture Thermometers*, 1849–1868; *and Earth Thermometers*, 1847–1873. Made at the Royal Observatory, under the Direction of Sir George Biddell Airy, K.C.B., Astronomer-Royal. (London, 1878.)

AN important contribution has recently been made to the meteorology of England by the Astronomer-Royal in the issue of this volume, which contains elaborate discussions of the photographic records of the barometer from 1854 to 1873, of the photographic records of the dry-bulb and wet-bulb thermometers from 1849 to 1868, and of the eye-observations of the thermometers whose bulbs are sunk to different depths in the ground from 1847 to 1873. The photographic apparatus and the details of the instruments and their mounting are fully described, and the methods for the reduction of the photographs to numbers, and the discussion of the results, are explained at length.

There can be no doubt that in these twenty years' averages we have the closest approximation to the mean monthly diurnal inequality of the barometer, in other words, to one of the prime factors of the meteorology of Greenwich. Of special interest are the results for the warmer months of the year, which class Greenwich among the places in middle and higher latitudes, whose climates are more or less continental in their character—these more special features being the occurrence of the forenoon maximum as early as 9 A.M., and a marked diminution in the amount and amplitude of the morning minimum. The almost strictly local character of the diurnal phases of atmospheric pressure, as disclosed by the observations at Greenwich, is seen from the occurrence of the A.M. maximum an hour earlier at Kew, where also the A.M. minimum becomes still less pronounced than that of Greenwich. On the other hand, at Falmouth, the A.M. minimum is much the greater of the two daily minima, and the A.M. maximum is delayed from two to three hours later than at Greenwich. Hence the true value of the Greenwich results can only be appreciated after a comparison has been made between them and the results obtained from other meteorological observatories.

An extremely interesting discussion has been carried out, showing the relations between the diurnal inequality of pressure and the different directions of the wind for the months. The results, while showing the double maxima and minima, show also in every case that the diurnal curve is thrown up or down, sometimes very considerably so. The reason for this uptilting of the curves or the reverse, is readily seen if we refer the phenomena to the European storms which affect the winds and pressure at Greenwich in their eastward course. Thus E., S.E., S., and S.W. winds, being in the front segment of storms, are accompanied with a falling barometer, and consequently the curves of diurnal inequality of pressure for each of these winds appear thrown down, most so in case of S.E. winds; whereas W., N.W., and N. winds which prevail in the rear of storms and are attended with a rising barometer, present curves which are thrown up, the uptilting with N.W. winds being remarkably great. These effects are most decided during the stormiest half of the year.

The observations of temperature are discussed with particular fulness, and the length of time is sufficient to give curves showing a diurnal inequality of temperature such as will substantially represent the curves for large portions of the south of England, not bordering the sea, where the thermometers are similarly placed to those at Greenwich.

The curves of temperature for the different winds have also been worked out with much elaboration, and give most interesting results. We would refer specially to the diagram on page 18, showing the air-temperature curve for December, with the diurnal curve for the same month, when the N.W. wind blew, from which it is seen that while the curve for N.W. winds has substantially the same form as the general curve for the month, it superadds a gradual fall of about 4°·0 during the twenty-four hours. On comparing the temperature of the air at midnight with that at the following midnight, it is shown that a clear sky lowers the temperature considerably in November, December, and January, but raises it in other months, particularly in May, June, and July; whereas an overcast sky scarcely disturbs the temperature, so that on an average it stands at the same point at the end as at the beginning of the twenty-four hours. On the average of all months the N. wind is the coldest, the S.W. the warmest; the order as regards temperature, beginning with the coldest, is N., N.E., N.W., E., S.E., W., S., S.W.—an order, however, which differs in different months. The results of changes of wind differ greatly with season; thus a change of wind from N.E. to S.W. raises the temperature 11°·0 in January, but only 0°·3 in June.

The earth thermometers were made under the superintendence of the late Prof. J. D. Forbes, and placed in position in 1846, the graduation of these thermometers having been made by Prof. Forbes himself. The hour of observation has been noon, but during 1846-47 observations were made every two hours, from the results of which "corrections" have been obtained for the reduction to approximate mean temperatures. The following are among the more important results:—

	Earth thermometers at depth of				
	1 inch.	3·2 feet.	6·4 feet.	12·8 feet.	25·6 feet.
Mean coldest month . . .	Jan. 40°·38	Mar. 42°·48	Mar. 44°·79	Apr. 46°·42	June 48°·94
Mean warmest month . . .	July 64°·34	Aug. 61°·38	Aug. 59°·60	Sept 55°·74	Nov. 52°·21
Difference . .	23·96	18·90	14·81	9·32	3·27
Mean annual temperature	51·24	51·13	51·53	50·87	50·55

The mean temperature of the air from observations made with a thermometer in the perforated wooden box protecting the projecting scales of the thermometers is 51°·59. But with the view of giving a more exact comparison between the temperature of the air and that of

the earth, a table (p. 100) of the mean monthly temperatures of Greenwich from October, 1846, to December, 1873, is given. The method by which this table was constructed is thus described :—

"The values for 1847 are the simple means of two-hourly observations; those for 1848 are the means of usually six observations daily, corrected for diurnal inequality by application of corrections derived from Mr. Glaisher's paper 'On the Corrections to be Applied to Meteorological Observations,' in the *Philosophical Transactions* for 1848, Part I. The means for 1849 and all succeeding years are found by combining eye-observations, taken usually four times on each day, and corrected for diurnal inequality, with observations of the maximum and minimum corrected by a quantity (taken from Mr. Glaisher's paper) peculiar to the period of the year. These temperatures may be regarded as accurate mean temperatures."

From this table the annual mean temperature of Greenwich comes out as 49°·43, being 1°·9, 1°·7, 2°·1, 1°·4, and 1°·1 in excess of the earth thermometers from the surface downwards. This large excess raises a doubt as to the correctness of the method adopted in calculating the mean temperature at Greenwich. Looking at Table 43 we find the mean temperature at every hour of the day for the month of June, with the number of days each, of the years for which observations were available for striking the means. On eight of the years the record was complete, and on these years, therefore, the mean temperatures deduced by the two methods should agree closely, if the method of calculating the means quoted above be a correct one. A comparison shows that in none of the months is there any agreement, the extreme differences being 1°·5 for June, 1865, and 0°·7 in June, 1863, and the mean difference for the whole eight years, 1°·0. The true mean—that of the twenty-four observations each day—is in all these cases in excess of the other mean. Similarly May, October, and January were examined, with resulting mean differences of 0°·5, 0°·3, and 0°·2 respectively. It follows that the mean temperatures, which are the most important element in the climate of Greenwich, remain still to be calculated.

When this has been done it will probably be found that the mean annual temperature of Greenwich has been understated by half a degree, and that consequently the mean for the twenty-eight years ending with 1873 was 50°·0. This supposition is rendered the more probable by applying the noon correction from Greenwich daily inequality tables to the mean of the temperature inside the perforated box protecting the earth thermometer. The mean annual temperature then becomes 50°·1.

In a large number of the years the third barometric maximum, first noticed by Rikatscheff as occurring in certain regions of the globe a little after midnight, appears in the Greenwich diurnal curves for December, January, and February, less frequently in March, and seldom or not at all in the other months. The somewhat rough method which has been adopted in reducing the barometric observations to 32° unfortunately renders the evidence furnished by the Greenwich results regarding the more refined inquiries of meteorology, such as this, and the mean diurnal inequality of the barometer in the lunar months, not so satisfactory and conclusive as might have been wished.

ALEXANDER BUCHAN

CHEMICAL DENUDATION AND GEOLOGICAL TIME

Chemical Denudation in Relation to Geological Time. By T. Mellard Reade, C.E., F.G.S., Past President of the Liverpool Geological Society. (London: David Bogue, 1879; pp. 61).

THIS little book is made up of three papers: one on "Geological Time;" a second on "The Geological Significance of the *Challenger* Discoveries;" and the third on "Limestone as an Index of Geological Time." The last paper was read before the Royal Society in January, 1879, and the others have been read before the Liverpool Society, of which the author is a distinguished member. Although, therefore, not new, these papers are well worth reading, for a vast amount of good solid fact is environed by curious calculations, and by hypotheses of a highly exciting nature. That is to say, exciting to the prosy realistic disposition of modern geology. This meritorious work, however, is slightly depreciated by the introduction of matter which is not strictly consistent with the results of modern research. Nevertheless, on the whole, the work may be considered very satisfactory by those who believe that doubt is the mother of progress; for all the hypotheses and conclusions in it are the product of a geological imagination of the highest and most vigorous order, and are of course open to objection. In the introduction it is stated that the author, during an attempt to estimate the amount of "solid matter conveyed annually in solution" in river-water to the sea from the surface of England and Wales, had a "new modulus" come into his mind, which might enable him to gauge the vista of the immensity of past time, or rather to arrive at "a minimum limit to the age of the earth." The result is thus stated: "If we imagine the area of England and Wales consisting of 58,300 square miles, to form one river-basin, the delivery of water by such river would be 68,450,936,960 tons, or 18·3 inches per annum, containing a total of 8,370,630 tons of solids in solution, representing a general lowering of the surface from that cause alone of ·0077 of a foot per century, or one foot in 12,978 years." Taking the "soluble denudation" of other parts of the world into consideration, Mr. Reade considers "that about 100 tons of rocky matter is dissolved by rain per English square mile per annum." This he states contains 50 tons of carbonate of lime, and twenty of sulphate of lime, &c., and proceeds: "If, as is generally supposed, the sea contains only what is washed into it from the land, and we can estimate its numeral contents in tons, we at once get a minimum measure of the age of the earth." As Herschel states that the ocean contains 2,494,500 billions of tons of water, and the mean of Dr. Frankland's analysis gives 48·9 tons of carbonate of lime and magnesia, and 1,017 tons of sulphate of lime and magnesia in 100,000 tons, it follows, according to the author, that it would take 25,000,000 of years to accumulate the quantity of sulphate of lime and magnesia contained in sea water, but only 480,000 years to renew the carbonate of lime and magnesia, and the discrepancy is caused by the appropriation of the calcic carbonate by mollusca for their tests. The amount of visible sediment brought down mechanically by rivers, as calculated for the whole world upon the results of Humphreys and Abbot for the Mississippi, and the

estimate is given at six times the amount of the soluble matters. This produces over the whole globe an amount of denudable matter equal to 600 tons a square mile per year. Going back in all time at this rate, and allowing for coast erosion, glaciers, &c., the ten miles of sedimentary strata must have occupied 526 millions of years in accumulation. The author readily disposes of Sir William Thomson and tidal retardation, and his limits of time. His calculations are "fallacious through leaving out agencies that we know are at work, and which the calculations I have submitted bring out in greater force."

He admits that he does not know how deep the sedimentary strata are, and it does not appear to have entered into his calculation that there was from the beginning carbonate of lime and sulphate of lime in sea-water, that the rainfall must have varied during geological time, and that the denudation of the surface has brought rocks of different solubilities within the reach of rain. Again, his calculations are vitiated by the fact that a vast amount of water percolates through many kinds of strata and does not come into the neighbouring river valleys, and that there are great artesian collections not in communication with the sea. In fact, one of the great problems of the day is to explain what becomes of vast quantities of such water. We must leave the author to settle with Prof. Geikie all those interesting calculations which are founded upon the hard and fast lines of uniformity.

There are some remarkable statements in this essay. Thus Hutton "laid the foundation of our present knowledge of physical geology." He gave us the grand method of geological study, but certainly many of the facts were well known before his time, and others have had no relation to his researches or method. Then there is the curious notion resuscitated as "a result of the *Challenger* expedition," that the calcareous portions of the dead foraminifera are dissolved by the carbonic acid in the sea before they reach the bottom. There are calcareous organisms in the red clay nevertheless, but perhaps they have escaped. It was a pretty idea that Thomsonian myth of the nymph Globigerina sinking into the arms of Neptune, and falling blushing and nude on to the abyssal floor, turned, like Adam, into red clay. But myths are not science, though there is a science of myths. In his paper on the *Challenger* discoveries, the red clay is a terrible incubus; and the following quotation will show that the author's physics are sometimes confused:—

"Now, this lowering of the bottom temperature over such immense areas is certainly a remarkable and unexpected fact, and shows that the secular cooling of the earth must be extremely slow, as to all appearances contact with the bottom does not in any case appreciably influence the temperature of the bottom water."

As a matter of fact the author is wrong in giving the *Porcupine* credit for discovering the great extension of the globigerina ooze, and he is not justified in calling the nodules of the red clay peroxide of manganese, for there is much iron in them, and he has been misled as to their vast quantity.

One of the funny notions of some scientific thinkers meets with no favour from Mr. Reade, whose geological knowledge is practical as well as theoretical. They consider that because the older rocks contain nothing like the present red clays, &c., of the ocean floor, that the oceans have always been in their present positions. Mr. Reade points out that the first proposition is not that proven, and the distribution of animals and plants and the fact that the bulk of the strata on land are of marine origin are opposed to the hypothesis. He very properly waits with the rest of the world for the final publication of the *Challenger* facts, and in the meantime enjoys the theories.

In the last of his papers the author begins by asserting that "The geological history of the globe is written only in its sedimentary strata." He proceeds to state that limestone rocks have been in process of formation from the earliest known geological period, and measures the absolute quantity of carbonate of lime in the sedimentary rocks. The depth of these he tries to estimate by borings! by the cañons of Colorado!! by the denudation of Suliven!!! by the amount of downthrow of faults and the thickness of the strata of mountain masses. In fact by every way except the right one, by the process of the gathering section. He considers that one mile is about the average thickness of the sedimentary crust, and that one-tenth of it is limestone, or 528 feet enveloping the globe. On the strength of former calculations, he believes that one foot of this universal stone would take 1,139,032 years to accumulate, or that in round numbers—a million or two are nothing in the way of argument—the whole occupied 600 millions of years, and this is the minimum age of the earth since the first Laurentian sediments. Mr. Reade has given a number of most valuable facts in his book relating to water flow and soluble matters, and his readers will pardon him for running a little riot in his theories.

LETTERS TO THE EDITOR

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[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Colour-Blindness.

THE normal perception of colour, according to the Young-Helmholtz theory, depends on the coexistence in the retina of three sets of nerves capable of conveying three distinct sensations, and excited most strongly by ether-vibrations of three distinct rates. The simple sensations conveyed to the sensorium by these nerves are known as primary colours (red, green, violet), and all other colour-sensations are produced by combined action of at least two out of the three in various proportions. Dichromic vision is explained by the absence of one of the three primary sensations, in most cases that which corresponds to the long-wave sensation, red.

Dr. Pole points out, in his article (NATURE, vol. xx. p. 477) that this hypothesis does not account for the most typical condition of colour-blindness, such as he describes in his own case. It seems to me, however, that a slight modification of the theory is all that is necessary to obviate this objection.

I would suggest that the nerve-fibres are not always most strongly excited by exactly the same wave-length, or, in other words, that the primary colours are not precisely identical in all normal eyes. There may well be small differences, and it is only when the divergence is great that the differences are appreciable and "colour-blindness" is noticeable.

Such a purely personal and subjective question as whether all normal eyes are similarly affected by similar light-waves is, of course, difficult to determine; but at least it is possible that a very slight structural difference in the nerve-ends of the retina may occur, sufficient to render them excitable chiefly, let us say, by the more rapid waves at the sodium line D, instead of the slower waves of line B.

In Dr. Pole's typical case of dichromic vision, the sensation which is absent is the middle one, and the two existing sensations are not both identical with those in normal eyes, but have their maximum impressions produced by vibrations whose rates are nearer together, so as not to leave the retina insensible to the middle of the spectrum. His long-wave colour corresponds with the sodium line D, which is therefore a primary to him, and his short-wave primary is probably violet; green light, accordingly, causes very little sensation, or will appear yellowish or bluish, as its vibrations come within the scope of one or other of the two existing sets of nerves.

It appears to me, *à priori*, that it is not unlikely, in the case of the absence of the intermediate (green) sensation, that the other two sensations should become approximated, so as to be of more use in discriminating a continuous series of colours; and such an "equilibration" is analogous to the hyper-sensitiveness of touch or hearing to which a blind man attains, one channel of communication with the external world the more readily lending its aid when another is closed.

This hypothesis of *individual differences in the primary colour-sensations* seems satisfactorily to remove the apparent violence done to the facts of dichromic vision by the Young-Helmholtz theory, and to accord with all other evidence of the physical basis of perception of colour.

A. H.

Prof. Mivart on "Tails"

IN the Davis lecture (NATURE, vol. xx. p. 509), Prof. St. George Mivart remarks that kangaroos use their tails "to a certain extent in their long jumps." This may either mean that the tail is used as a balance to the fore-part of the body—as, of course, is the case—or as a means of propulsion. The latter is the natural inference to be drawn from the sentence.

The belief that kangaroos thus actively employ their tails is of wide extent in Australia, but a residence there of over three years, principally in the bush, so thoroughly convinced me that the idea was erroneous that I think I am justified in challenging the Professor, if I have not misinterpreted him, to give the evidence on which his statement is based.

As we have recently learnt, through photographs of a galloping horse (*vide Field*, June 28, 1879), eye observations, where movements are rapid, are not entitled to much weight; but still, as I have seen many hundred kangaroos pass at full speed, and have observed them especially in reference to this question, some little dependence may be placed on my assertion that the action of one of these animals in full stride is incompatible with the use of its tail as a third hind leg.

In the descent of the kangaroo in each leap, the tail swings freely upwards to a curve, whose arc is at about right angles to the slope of the back, and during the rise of the succeeding leap it falls, and is then apparently impeded by muscular action. Were the tail actively employed, it would have to strike the ground almost at the same moment as do the feet, and the whole form of the animal would be altered. The tail would have to be brought down rapidly, like a riding whip, whilst the upward swing would be retarded.

From the forward slope of the body in long leaps and the fact that then, of the hind limbs, only the feet touch the ground, it is evident that the portion of the tail that alone could be employed as a propeller would be the posterior and weaker part.

Again, if we consider the speed of the kangaroo over the ground—say, 15 miles an hour, or 7½ yards in a second—we find that only length of bones and mobility of joints of the hind legs permit the feet to rest on the same spot of ground for even a fraction of a second. With the tail it is otherwise; in the position it is carried by the animal it must travel over the surface for some two feet, though but pressed against the ground for a tenth of a second. I fear not even the callous under-surface of a kangaroo's tail would long stand such terrible attrition.

If further evidence is wanted, it is to be found in the tracks left by kangaroos, wallaby, &c., that have travelled quickly over sand, mud, &c. There is seldom to be seen the mark of a tail, and then only as a graze. The very tendons of the tail are an argument against its utility in leaping, for those on the upper side are twice as powerful as those on the under.

In conclusion let me say that it has been suggested to me that the remark about kangaroos making use of their tails to carry grass might lead to the supposition that their tails are prehensile.

E. H. PRINGLE

Beckenham, September 29

IN Prof. Mivart's interesting lecture on "Tails" the statement occurs that kangaroos "make use of their tails to a certain extent in their long jumps." This I believe to be an entire misapprehension. No doubt the massive tail of a kangaroo suggests the possibility of such use, and the idea is helped out by the very obvious employment of its tail by the animal in almost all its slow movements, when it rests of necessity on the ground. In leaping, however, the body is thrown forward at an angle which raises the tail from the earth. On the great sandy flats about the shores of Moreton Bay, kangaroos have often afforded me the opportunity of convincing myself that the tail touches the earth only occasionally and very lightly, probably when the balance of the body is not perfectly maintained. I have traced the marks of the great hind toes over this sand when damped by rain, and in the best condition to take the slightest impression, and have never found anything more than a *very faint* mark now and then, and that evidently such as had not been produced by any effort of the animal to urge itself onward by means of its tail. In one instance the track of a kangaroo, which had crossed a flat within sight of me at full speed, happened to cut the track of some small wading bird, which enabled me to compare the deep holes made by the powerful stroke of the hind legs with the shallow oval mark made by the tail, about half a dozen times only in a distance of about four hundred yards, and the track of the bird. Had any propulsive force been used, this mark must have been very distinct on a surface capable of taking a perfect impression of the bird's foot. The rock kangaroos leap in exactly the same manner as their larger congeners, yet their long and comparatively slender tails could hardly be supposed by any one to render them any assistance. Even in the confined space allotted to them in the Zoological Gardens it may be seen that kangaroos leap without any help from their tails, and when they are going very fast the axis of the body is thrown forward into a position approaching the horizontal, and the tail is then quite clear of the ground. Prof. Mivart is not singular in his misapprehension on this point, for I find in Prof. Alleyne Nicholson's "Manual of Zoology," edition 1875, p. 580, that "the tail is also extremely long and strong, and by the assistance of this organ and the powerful hind limbs, the kangaroos are enabled to effect extraordinarily long and continuous leaps."

ARTHUR NICOLS

About Snakes

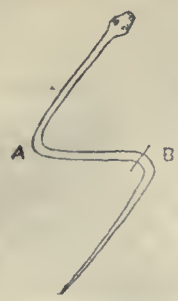
HOW do snakes progress? I ask this question in full knowledge of all that has been written on the subject, and nought that I have read satisfies my mind nor meets all requirements. The books tell us that the ribs of the snake are its legs. All well and good, as long as we are dealing with smooth plane surfaces and sluggishly moving snakes, as the boas; but the theory utterly fails with snakes which literally fly through grass, or climb trees or walls with equal facility. On one occasion I allowed a boa to pass over my hand pressed flat on the ground, and I distinctly felt the onward movement of the rib legs, acting exactly like the outside legs of the centipede, and I felt quite satisfied that, under the circumstances, the snake was moving by means of its ribs.

But this timid and harmless rat snake, which you see absolutely flying through the grass to escape you, cannot be moving by the aid of its ribs; for first, there is nothing for them to act on, and secondly, you cannot imagine the ribs acting rapidly enough to ensure the immense speed at which the animal passes through the high grass. Look at this tree snake surveying you from a bough; how did it get there? The books will tell you, by winding itself round the tree, and thus progressing upwards; but a slender snake of 12—18 inches in length cannot grasp a trunk 2 feet in diameter for the first start up the tree, and so it must get up some other way.

How did this little snake 9 inches long ascend the side of a glass jar 10 inches high, and assume the position I shall presently describe? Certainly its rib legs gave it no assistance.

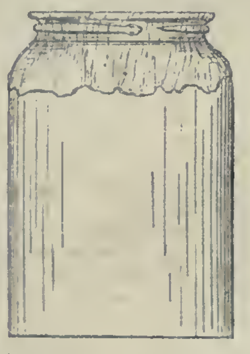
The man who brought the boa, had with him an earthen pot full of small ash-coloured snakes, quite new to me, and I never saw ferocity and activity more remarkably combined than in those small reptiles; on taking them out by the handful, they fastened their jaws (well armed with teeth) upon the man's hand and wrist, and hung like gigantic leeches. Accustomed to such attacks, the snake owner removed the little demons, each separately, with some difficulty, and the wounds bled freely. But the activity, and mode of progression in these snakes interested me more than their ferocity; thrown on the ground they

immediately assumed this figure, and then began to fly about in



all directions, requiring some trouble and agility in re-collecting them. I analysed their progression carefully, and found it to be both progressive and retrograde, the former predominating. The body at B seemed to become rigid for a second, allowing the upper part A to be thrown, not *crawled*, forward, and thus for a second the animal was straight; then A, with a slight retrogression, became rigid, and B advancing, the animal assumed the shape shown. It advanced with astonishing rapidity by a series of jerky undulations. In fact, making full allowance for friction, the snake swam on land, and its rib legs were of no use whatever to it in progression.

Now let me say a few words about the small snake in the glass jar, and I shall then be in a position to advance my ideas about anguine locomotion. As before mentioned, I placed the little creature (a harmless one) in a large glass jar ten inches high, and stretching a bit of coarse muslin over its broad mouth, secured it by an elastic band. A day or two after, I was much surprised to find my snake gone, and more so to find the muslin band and elastic ring intact. No one had touched the jar, for a wholesome dread of snakes existed in the house, but yet the little animal had disappeared. On closer examination I discovered it *coiled outside the neck of the jar below its lip, and between the muslin and the glass*, thus—



How did it get there?

Deeply interested, I replaced the snake in the jar, and carefully watched its attempts to resume its strange position. I found it had no difficulty in ascending the side of the jar and standing erect on its tail, and its movement in doing so was graceful, unconstrained, and directly upwards. Watching more closely, *I saw the snake distinctly adhering to the glass*, its abdominal scales creating a vacuum exactly like the pedal scales of the common house-lizard. *There was not a doubt of it*, and I felt quite satisfied as to how snakes get into the strange localities in which they are found out here, and which I shall presently describe.

In many native huts you find cupboards extemporised by building round earthen pots, called gharrahs, into the mud walls, their mouths being flush with the smooth plastered walls, and about four feet from the ground, and one from the slope of the thatched or tiled roof. Cobras often are found coiled up in these pots, and the first intimation is the fatal strike at the hand of any one rummaging in the pots. How did the snake get there? "Off the roof to be sure;" but how did it get on to the roof of an isolated hut with smooth mud walls? How did the deadly kerarts get up into my bookshelves, where I have often found them coiled up on my books. Of the deadly snakes, this is the only one of a literary turn, and it is frequently found among books, a rather dangerous haunt for those who frequently refer to them. How did the cobra get into the double roof of my brougham, and frighten my wife out of her wits by wishing to share its interior with her? How did another get into the sleeve of my wife's dress, which was hanging two feet from the ground, on a wall peg?

I believe terrestrial snakes move in one or other of the following ways:—

1. On smooth plane surfaces, by means of their rib legs; *e.g.* the boa.

2. Through high grass, by a rapid, almost invisible, sinuous onward movement, as the hydrophidæ in water; *e.g.* the rat snake.

3. Climbing trees, or ascending smooth surfaces by erecting their abdominal scales (for climbing) or using them to produce a vacuum, as lizards do their foot scales for ascending smooth surfaces, *e.g.* tree snakes and cobras in native cupboards.

Deglutition in Snakes.—Soon after the capture of my little snake of the glass jar, I presented it with a frog, and watched proceedings. And here let me note that the snake was 9 inches long, with a delicate little head not ½ an inch broad, while froggy was 2 inches long and 1 broad. Bearing in mind the old puzzle, "What's smaller than a mite's mouth?" "That which goes into it"—I watched proceedings with great interest, and was well rewarded, for the snake immediately seized froggy by the nose, the animal making desperate attempts with fore and hind-legs to shake it off, but all in vain. All this while the process of deglutition (?) was going on remorselessly, or rather, the snake was slowly but surely getting outside the frog, and in this fashion: by a sort of vermicular process you could see the sharp little teeth advance a little, and then the whole body wriggle up to the new hold on froggy's head. And so it very gradually disappeared; then came the shoulders, and the arms followed, pressed against the sides. When the teeth reached the sacrum the legs were violently convulsed, then they disappeared, and last of all the toes, and the snake was fairly outside froggy. Overjoyed, he rubbed his lips against the sides of the jar, gave two yawns, and then composed himself to digest. The whole process lasted exactly half an hour.

Snake Charmers.—I had not been many years in India when I had an excellent opportunity of seeing the so-called snake-charming, and of satisfying myself that it was only clever *legerdemain*. A couple of snake-charmers appeared in the compound and offered to purge it of all the snakes it contained. I embraced the opportunity with great alacrity, but insisted on dictating my own terms, which, after some demur, were agreed to. I selected one man (the other remaining with the baskets), and offered him the choice of accompanying me, either in his dhotee[1] only, and a bare head; or with his pugree[2] and a langootee.[3] He chose the latter costume, soon made his toilet, and stood before me all but naked. I satisfied myself that the langootee could not possibly conceal a snake, and I had yet to find whence the reptile could, or would be produced. So we proceeded to business, accompanied by a crowd of gaping servants. I led the way to a great prostrate trunk, beneath which a cobra (imaginary) was said to lodge, and here he started his rude bagpipe, and began his incantations and gesticulations. But the snake refused to be charmed, for the very good reason that it was not there, and the charmer could not evade my searching gaze. He now took the lead, and drew up before a tempting looking hole in a bank, where he felt sure he could seduce a snake. "Very well," said I, and we formed a semicircle, in the middle of which he stood, and resumed his incantations. Suddenly, to divert my gaze, he pointed to the hole, and exclaimed, "Dekho, sahib!" (look, master), and in a moment, extracted (apparently) a cobra from it. But he did not see that, in that moment I had observed his hand, like a lightning flash, extract a snake from the folds of his pugree, and simultaneously appear to extract it from the hole. The *modus operandi* was clever *legerdemain*, but unmistakable cheating. One of my servants saw the trick too, and was about to exclaim, but I silenced him with a gesture, and appeared convinced at the marvel. "Now," said I, "as you have found the snake, you must prove to me that it is poisonous," and so a poor chicken was sent for, and placed under a coop with the snake, but here again the snake-charmer overdid his performance, for dislocating the chicken's neck with his finger and thumb as he placed it under the coop, he immediately raised it, and

[1] *Dhotee*, the voluminous waist-cloth worn by all Hindoos.
[2] *Pugree*, the cloth worn round the head.
[3] *Langootee*, a narrow strip of cloth worn between the thighs of the male, just sufficient to hide his nudity.

exhibited the poor animal dead. If it had been struck by the snake, 10-15 minutes would have elapsed before death. I still seemed convinced, and on his coolly asking for the chicken for his dinner, I said I could not think of allowing him to eat a poisoned animal, and so ordered it to be buried.

Having received their bakhsheesh, both men asked me for some brandy: as, at the moment, there was none in the house, and telling them so, one pointed to a large bottle of saturated tincture of ginger which was standing in the sun, and asked what it was. On my telling him, both asked for some, so I bade them sit down, and poured a mouthful down each gullet. The unexpected pungency of the shrub astonished them, but one of them, pressing his stomach with both hands, and with his eyes streaming with tears, gasped out "aur do" (more give). The other man said he had had enough. Both then rose, and shouldering their baskets, salaamed and left the compound.

Skin shedding among Snakes.—Though I have handled exuviæ by the hundred, and some of them just cast, I have never witnessed the process of skin-shedding, nor, I believe, has any observer.

It is well known that the skin is always found inverted, and very often, quite entire; and the general impression is that the snake fixes itself in a bush, or strong grass, and then wriggles out of its skin. But I have found the skin on the floor of a bath room, and on the rough ballast of a railway.

I believe that fixture is obtained by means of the abdominal scales, and that then the *modus operandi* is as follows: the skin ready to be cast, yields round the snake's mouth only, and remains adherent to the extremity of the tail. As the animal advances the caudal extremity of the skin is inverted, that is, pulled inwards, and so the process goes on, and is completed by the tail passing through the mouth of the skin; and thus the direction of the abandoned skin is directly opposite to the direction taken by the skin-casting snake. That is, if the mouth of the skin lies east, the snake went out to the west.

Take the finger of a glove, and pass a knotted thread inwards through its tip, then pull gently on it, and the tip of the glove will pass inwards and downwards, and ultimately pass through the base of the finger, which will now be uppermost.

Peshawar H. F. HUTCHINSON

(*To be continued.*)

A Plague of Rats

I HAVE read with great interest in NATURE, vol. xx. p. 65, a note of Mr. Orville A. Derby's on plagues of rats in Brazil. The same thing occurs sometimes in the south of Chile, Araucania, Valdivia, and Llanquihue, when the Coligue, and other species of the Bambuseæ have flourished and fructified, an occurrence which happens every 15-25 years. These grasses, with solid canes, unbranched, of sometimes more than 10 metres long and 8 cm. thick, flourish only once in their life, when they are 15-25 years old, and then their fruits ripen in astonishing quantity. This causes an enormous multiplication of rats and mice in the woods, animals rather rare commonly; and at the end of the same or the beginning of the next year, these animals have finished with their food, and are then obliged to migrate to the cultivated districts, where they are very noxious. The Indians collect the seeds of the Coligue as food, as the Brazilian natives seem to do with the fruit of the bamboo. I had occasion to observe this fact in 1869 or 1870, when I lived in Valdivia, and when almost all the Coligues of the province flourished at once and died afterwards; and I had heard it already before from the natives. FEDERICO PHILIPPI

Santiago, Chile, August 17

Solar Halo

ON Monday, September 22, about 12 o'clock, on the coast at Burnham, Somerset, my little boy called my attention to a large, clearly-defined, white circle, of which the zenith might be the centre; on the southern side of the circumference was the sun, above which were the arcs of two other circles, one of which was flattened. They united at a small distance above the sun, and displayed rather dull prismatic colours; between the points where these arcs joined the large white circle were two rather oval-shaped patches, also showing prismatic colours. The appearance lasted about an hour and a half. G. MAPLETON

Badgworth Rectory, Weston-super-Mare, September 23

CHEMICAL ACTION

WHY are the properties of bodies so profoundly modified by the action called chemical? Why do *certain* bodies *only* act chemically upon one another? What exact meaning is to be attached to the expression "chemical affinity?"

These questions, and questions such as these, have engaged the attention of chemists since chemistry began to be an exact science.

The products of chemical action are innumerable: chemical science is encumbered with a multitude of compounds, and each day additions are made to the number; but no general theory of chemical action has yet been broached which suffices to explain the known facts.

The consideration of the initial and final distribution of matter in a system upon which chemical action is exerted, has almost entirely engaged the attention of chemists, to the exclusion of the study of the course of chemical change, the conditions modifying this change, and the nature of the force which causes the change.

The molecular theory of matter furnishes us with a fairly complete answer to the question—Wherein consists the essential characteristic of chemical action?

Chemical action, says this theory, results in the production of new molecules, mechanical action results in changes in the rate of motion of existing molecules.

But why are new molecules formed only when certain bodies are brought into contact and not when other bodies are placed under similar conditions?

Because the first substances exert chemical affinity upon one another, whilst the others do not.

But what is chemical affinity?

The expression affinity was originally used to denote a resemblance between certain substances which exerted an action of some kind upon one another. But when the study of chemistry advanced, it was found that those bodies which most readily exerted mutual chemical action, were, as a rule, unlike in their chemical habitudes.

The expression affinity was, however, retained to express the fact that one body exerted chemical action upon another. This affinity could not be measured in terms of any unit, hence chemists were content to draw up tables of relative affinities. These tables were for the most part based upon qualitative reactions, and supplied merely empirical information.

In the year 1780 Bergmann formulated a general theory of chemical affinity: the main points insisted upon by Bergmann were, that the affinity between two bodies is independent of the masses of the bodies brought into mutual contact, and that the value of this affinity is constant under similar conditions. Bergmann further supposed that the relative affinity values of various substances may be empirically represented by the amounts of these bodies which mutually combine together: thus in the formation of a series of normal salts, the affinity of the acid is greatest according to Bergmann, for that base, the greatest amount of which is taken up by the acid. Conversely a base has the greatest affinity for that acid which combines with it in greatest quantity.

The latter part of Bergmann's theory could no longer be upheld when the atomic theory of Dalton had introduced clearer views concerning the quantitative action of chemical substances upon one another. But the atomic theory was not opposed to the view that the affinity between the bodies is independent of the masses of the bodies brought into mutual contact.

In the year 1803 Berthollet published his theory of chemical affinity, a theory which was essentially opposed to that of Bergmann. The French chemist said that the chemical action of one substance upon another is proportional to the mass of the acting body and to its affinity for the second substance. Berthollet thus considered not only the affinity of one body for another, but also the masses

of the acting bodies. He further took into account the physical conditions under which the chemical change proceeded, inasmuch as he regarded chemical decomposition as not completed by chemical affinity alone, but by affinity aided by cohesion and elasticity.

Upon Berthollet's view of affinity, the affinity of an acid was greatest for that base with which it combined in smallest quantity; and a substance with very small affinity for the constituents of another was nevertheless capable of decomposing that other, provided a sufficiently large mass of the first was employed.

No important general theory of chemical affinity has been propounded since the time of Berthollet; chemists have now favoured his views, now the views of Bergmann, the preponderance of opinion inclining generally towards the theory of the French chemist.

In the year 1867 a most important paper, "Etudes sur les Affinités chimiques," was published in Christiania by Professors Guldberg and Waage. This paper has been supplemented by a second communication within the last few months by the same authors: the general theory of chemical affinity has been also materially advanced by three publications made by W. Ostwald, ranging from 1877 to the present year, and entitled "Volumchemischen Studien."

These papers undoubtedly mark an epoch in the development of chemical theory, presenting, as they do, the beginnings of the application of mathematical reasoning to the facts of chemistry, and furnishing, likewise, new methods for solving some of the more intricate problems presented to the chemist.

Guldberg and Waage consider specially the influence of mass upon chemical action. In the general equation $A + B = A' + B'$, where A' and B' represent the new substances formed by the mutual actions of A and B, we have two forces at work, that causing the formation of A' and B', and that tending to re-form A and B; for any given stable condition of the system A, B, A', B', these two forces are in equilibrium. The force causing the formation of A' and B' increases proportionately to the coefficient of affinity of the reaction, and is also dependent upon the quantities of A and B present. If the *active masses* of A and B (that is, the masses of these bodies present in unit volume of the reacting system) be denoted by p and q respectively, and the coefficient of affinity by k, then the force is represented by the expression kpq.

This expression may also be regarded as representing the amounts of A and B, transformed, in unit time, into A' and B'.

By a similar method the expression $k'p'q'$ is arrived at as representing the force which tends to bring about the reformation of A and B. The condition of equilibrium of the system is such that $kpq = k'p'q'$.

If $pqp'q'$ be experimentally determined, the proportion $k : k'$ can be calculated, and hence the limit of the reaction for each initial condition can be determined.

Guldberg and Waage have applied their law of mass action to a number of special cases of chemical decomposition, the more important of which are decomposition of carbonates of the alkalis by barium sulphate, and the reverse action, formation of ethylic acetate and water by the action of alcohol upon acetic acid, division of a base between two acids, decomposition of hydriodic acid in presence of an excess of either iodine or hydrogen, &c.

Those actions which consist of two parts—the direct and the reverse chemical change—are especially adapted for the study of the influence of mass. This class of action is regarded by Guldberg and Waage as complete, while those in which—by the removal from the sphere of action of one of the products of the first part of the change or by other means—the reverse action is not accomplished, are regarded as incomplete. The combination of hydrogen and oxygen, for instance, to form water, is but one phase of the complete action, the other phase of which is the decomposition of water into hydrogen and oxygen; by conducting the first part of this action at a temperature above that of the dissociation temperature of water, the action becomes complete.

In their view of chemical action, Guldberg and Waage regard the molecules of the reacting substances A and B as composed of the atoms $\alpha\gamma$, and $\beta\delta$ respectively; these atoms are supposed to perform their own vibratory movements within the respective molecules. At certain points the force acting between α and γ and between β and δ is supposed to be very small; if, when α and γ are in this position, the molecule B come near to A, an exceedingly small disturbing influence may determine that α and β and γ and δ pair off together, to form the new molecules A' and B'. A similar view is taken of the reverse action whereby A and B are reformed.

Guldberg and Waage consider in detail only the action of mass as influencing the force of chemical affinity, but they also recognise the existence of secondary forces due to the foreign bodies present, *i.e.*, bodies which do not directly undergo chemical change during the reaction under consideration. Among these foreign bodies is to be placed the liquid in which the salts are dissolved whose mutual action is to be studied.

That the degree of dilution of the reacting liquids exerts an influence upon the course of a chemical change is witnessed to by many well known facts. Quantitative measurements of this influence are not, however, numerous.

If a molecular explanation of chemical action be adopted, we should expect to find a marked difference between the modifying influence of physical conditions upon a chemical change occurring in a dilute and the same change occurring in a more concentrated solution.

In the former case, where the molecules of the reacting bodies are comparatively widely separated from one another by those of the diluent, and where possibly a larger amount of energy of motion is associated with each molecule, one might expect that small disturbing influences would produce a marked effect upon the course of the chemical change. And such an effect is produced by small changes in physical conditions.

As one result of experiments in which I have been engaged for some time, I find that when a dilute solution of strontium chloride is mixed with a dilute solution of sulphuric acid (the molecular proportions being as 1 : 3 or 1 : 4), the amount of strontium sulphate produced in a short time—thirty to sixty minutes—is very largely dependent upon such conditions as the manner in which the two liquids are mixed, the smoothness or roughness of the vessel containing the solutions, &c., &c. Similar results have been obtained in measuring the reaction between barium chloride and potassium oxalate in dilute solutions.

But however a special chemical decomposition may be influenced by such physical conditions as those mentioned, or by such physical conditions as temperature, time, &c., it seems very probable that each chemical molecule is possessed of a definite coefficient of affinity. The researches of Guldberg and Waage, as also those of Ostwald favour this view.

The law of mass action formulated by the former naturalists does not permit of determinations being made of the coefficient of affinity of any substance, but only of the ratio between the coefficients of two substances. Ostwald also does not attempt to do more than determine the *relative affinities* of substances.

He confines himself especially to the neutralisation of acids by bases; from his results he deduces the probable conclusion that the relative affinity of an acid is a fixed number independent of the nature of the base acted upon, and independent of temperature. The relative affinity is, however, a function of the absolute affinity which is itself

probably influenced by temperature, pressure, and nature of the base neutralised. Ostwald's researches show that the affinity exerted between an acid and a base may be regarded as the product of the specific affinity-constants of the acid and of the base; *i.e.*, as made up of two parts, one of which is dependent on the acid and the other on the base.

The connection between chemical structure and affinity is touched upon by Ostwald. His numbers show that while the relative affinity of acetic acid is represented by about 1·3 (nitric acid = 100), that of monochloracetic acid is represented by 7, that of dichloracetic acid by 33, and that of trichloracetic acid by 80. Similarly, the entrance of oxygen into the molecule of an acid increases the affinity, while the addition of CH_2 decreases the affinity.[1]

The importance of the results, a very short sketch of which I have endeavoured to give, cannot be overlooked. We seem approaching the time when exact knowledge will be obtained of that mysterious force, chemical affinity; but before this exact knowledge is attained, much work remains to be done. Not the least of the benefits bestowed upon their fellow chemists by the three naturalists whose papers I have mentioned, is that they have directed their attention to a branch of chemical science which, although it presents great difficulties, yet promises results of the most paramount importance to science.

Cambridge, August M. M. PATTISON MUIR

[1] The results of Ostwald, and also those of Guldberg and Waage, are corroborative of those obtained by Dr. C. R. A. Wright in a paper published in the *Phil. Mag.*, December, 1874.

NOTES FROM ICELAND

DURING the last three weeks the writer has travelled over between four and five hundred miles of country in Iceland, in the course of which various facts have presented themselves which may interest some of the readers of this journal. These "Notes" are necessarily desultory, because the main facts connected with the natural phenomena of the country are so well known that the most we can do is to supplement some of them.

Submarine Eruption off Cape Reykjanes.—The only eruption recorded in Iceland during the present year took place off Cape Reykjanes on May 30, near the Geirfuglasker island, thirty-two miles from land. It is described by a farmer named Guðmundsson, living near Kirkjuvogr, and his account of it is published in the *Heilbrigdistindi* for June last. Smoke appeared from the sea on May 30, and on June 1 it was carried inland by a west wind. For thirteen or fourteen days it was difficult to navigate the sea about Reykjanes on account of the smoke, and just before it cleared off, ashes fell on the coast lands. An appearance as of fire was also seen out at sea. This is positively all the information we possess concerning this eruption. It is sufficiently meagre, but the district about Cape Reykjanes is very thinly populated. The road, or track, is carried over a lava-stream, and is one of the worst in Iceland; the houses are few and far between, and the keeper of the lighthouse told us we were the only visitor he had seen this year. It is probable that volcanic phenomena often pass unnoticed in a country which is so thinly peopled, that with an area one-sixth larger than that of Ireland, the population (72,000) is less than that of Norwich. Submarine eruptions have more than once previously taken place in this district; small volcanic islands have been raised above the level of the sea, and have sunk again, leaving dangerous reefs. At Cape Reykjanes (hence the name) there are numerous hot springs which deposit silica, and which are therefore of the same nature as the geysirs. The springs rise through beds of highly decomposed tuff; large quantities of steam are emitted, and the soil in the vicinity is so soft that it is necessary to carefully choose one's footing. Pools of boiling blue mud (like the *maccalube* near Girgenti) are also found in the vicinity.

Craters of the Eruption of Hekla of February, 1878.—Last autumn we gave an account in this journal (vol. xviii. p. 596) of a visit to the scene of the new eruption, which took place about four miles from the principal craters of Hekla at the end of the preceding February. The observations of Herr Nielsens, a merchant of Eyrarbakki, and of Prof. Tomas Hallgrimson, were also recorded. The former has just communicated to the writer the result of certain measurements of the principal of the new craters, which he made a few months ago. Three of the craters in the centre of the group were measured. The form of the first is that of a funnel, 100 Danish feet[1] in diameter. A good deal of steam issued from the bottom of the crater, and prevented the depth from being accurately determined, but it appears to be about 150 feet. The second crater is of horseshoe form, the straight wall joining the curve of which, is perfectly vertical. The diameter increases as it descends, being at the top about 30 feet, and at the bottom 50; while the depth is also 50 feet. The third crater is of the shape of a parallelogram, 40 feet long by 30 broad, and 40 feet deep. The walls are perpendicular. No lava issued from the second and third of these craters, but quantities of ash and pumice. The greatest quantity of lava flowed from the most southerly crater nearest to the summit of Hekla. The approach to this is very difficult on account of the extreme jaggedness of the lava. The whole field of new lava appears to be covered with an innumerable quantity of small craters, but a closer examination proves that they have been produced by the molten lava beneath forcing out portions of the upper solidified crust, at places where snow or water caused the generation of large quantities of steam. Most of the real craters are split in twain, and the sides are lined with incrustations of common salt.

A few weeks ago Miss Thora Pjetursson, of Reykjavik, ascended Hekla, and reports the appearance of steam from one of the main craters; last year when we ascended the mountain no trace of steam appeared from any one of the three main craters, the most recent of which was formed in 1845. Hekla only enters into eruption at long intervals of time.

Slight shocks of earthquake are common in the south-east districts, in Guldbringu Sysla and Rangarvalla Sysla.

Climate.—The presence of jokulls covered with perpetual snow; of the Gulf Stream, and of an arctic current, tend to make the climate of Iceland very variable and subject to sudden changes. On August 20, when we left Kalmanstunga, in the centre of the island, the sun was as hot as during an English mid-August day; later in the day as we passed the Geitlands jokull a piercing icy wind bore down upon us with great force, and again towards evening when we entered the northern end of the Thingvellir valley it was warm and summer-like. During the course of that day we experienced a difference of more than 100° F. Again on August 30, at Eyrarbakki, on the south coast, N. lat. 63° 65′, the thermometer at 6 A.M. stood at $-1°$ R. = 29°·75 F., and a crust of ice had formed on all exposed water. At 10 A.M. a bright hot August sun was shining and the air was still. At 3 P.M. rain and violent wind occurred, and towards evening it again cleared up. Frequently the wind drops suddenly, and a complete change of weather may take place in the course of a few hours. The summer has been unusually dry and warm, but on August 31 the weather began to break up. On that day we travelled from Eyrarbakki to Reykjavik by way of Reykir (in Olfusahreppr), and we shall never forget the difficulties of crossing the Helliskard, a low spur of the mountain Hengill. The whole tract is either the living palagonite rock, or detached fragments heaped together in confusion. Hence it is only possible to proceed at a slow space. A violent wind

[1] One Danish foot = 1·125 English foot.

swept over the face of the mountain, driving the rain in almost horizontal sheets along the surface. From time to time mists floated over the mountain, and it was bitterly cold.

Iceland a Meteorological Station.—If Iceland were connected with the Faëroe Islands, and with the north of Scotland by telegraph, there can be no doubt that it would form a valuable meteorological station, although from the various disturbing influences the effect of which would be comparatively local, such as the jokulls and the various local currents, such a station would be less valuable than would be afforded by a vessel moored 600 or 800 miles out in the Atlantic between Ireland and Newfoundland, and in telegraphic communication with the central office in London.

Drift Wood of Iceland.—Great quantities of drift wood are thrown upon the southern coast of Iceland. It is said to be chiefly fir, and it is asserted by some to come from Siberia by an arctic current, and by others from America by the Gulf Stream. We noticed that the coast between Grindavik Staðr and Cape Reykjanes was far more thickly strewn with drift wood than the coast more to the east in the neighbourhood of Eyrarbakki. As the Gulf Stream impinges on the south-western peninsula, it would seem that it must therefore be the chief source of the drift wood. The trees that we saw were torn up by the roots, and they were completely blanched, and in many cases riddled with holes by some species of borer. A portion of the skeleton of a large whale was visible on the shore near Grindavik.

Improvements in Iceland.—During the year which has elapsed since we last visited Iceland, several very marked improvements have been set on foot. In no respect is this more conspicuous than in the case of the roads. A few years ago a writer made the assertion "there are no roads in Iceland." At the present time road-making is making great progress, and many scores of miles of excellent roads exist. Of course we mean such roads as alone are possible, without great expenditure of money and labour, in a country which is one vast volcano. Driving roads are impossible, but excellent pony roads are being constructed, and will greatly facilitate despatch of business and intercommunication. The first bridge in Iceland is about to be commenced. It will cross the Olfusà, and materially help to establish a better communication between the east and the west. A second bridge is to be thrown across the Thjorsa. The first lighthouse in the island was erected a year ago, and the light-dues paid by ships at the port of Reykjavik have already almost paid for its construction. There is some talk of founding a school of farming at Moðrudalr in the north-west, and a law school in Reykjavik, where a divinity school and a medical school already exist. In Reykjavik new houses are being built; there is a proposition on foot to build an hotel, and a new house for the Althing, which now holds its biennial meetings in the Latin school. Hafnafjord and Eyrarbakki are flourishing little ports; Akureyri does a fair trade in shark liver oil, and in ponies; and the Krisuvik sulphur mines appear to be in good working order, and to yield a rich product.

Reykjavik, September 2 G. F. RODWELL

ON HARMONIC RATIOS IN THE SPECTRA OF GASES

PROF. G. JOHNSTONE STONEY has given in the April number of the *Phil. Mag.* for 1871 some remarkable ratios of the wave-lengths of three of the hydrogen lines. Prof. Soret and Mr. Lecoq de Boisbaudran have also given several similar ratios, and I have found at various times a great many. It is, however, impossible to decide, without a thorough discussion, how many of these harmonic ratios may be due to accident. All possible fractions in a given spectrum ought to be calculated, and we could then see, by the theory of probability, whether the coincidences with ratios of comparatively small numbers are more numerous than we ought to expect. I began this work about a year ago. The calculation and discussion of twenty thousand fractions will necessarily take some time. The following simple ratios, however, which I have found in the iron-spectrum, I believe to be worth recording. I may say that I have gone only through the seventh part of that spectrum as yet. The first column in the following table contains the corrected wave-lengths of iron lines as given by Ångström. If these numbers are multiplied by the fractions given in the second column, we obtain the calculated values of other iron lines. The observed values and difference are given in the fourth and fifth columns.

λ	Fraction.	Calculated.	Observed.	Δ
6302·49	8 : 10	5041·99	5041·69	−0·30
6231·64	5 : 6	5193·03	5193·25	+0·21
6192·43	9 : 10	5573·19	5573·37	+0·18
	6 : 7	5307·80	5308·10	+0·30
6137·53	8 : 9	5455·58	5456·36	+0·72
	7 : 8	5370·34	5370·65	+0·31
6066·39	7 : 8	5308·09	5308·10	+0·01
6009·32	8 : 9	5341·62	5341·87	+0·25
	2 : 3	4006·2	4006·0	−0·2
6003·92	7 : 10	4202·74	4202·75	+0·01
	5 : 6	5003·27	5003·52	+0·25

The differences could of course be reduced to one-half by throwing part of them on the possible errors in the observation of the wave-lengths given in the first column. It is to be remarked that the intensities of the iron lines which figure in the above table are as a rule very strong. Thus all but three of the lines have an intensity of over six attached to them in Watts' Index.

The following table contains a set of iron lines, which can be arranged as harmonics of a fundamental vibration whose wave-length is 0·018694765 of a millimetre.

The table is arranged according to the pattern of that given by Prof. Stoney for the hydrogen lines.

Observed wave-lengths in vacuo.	Calculated values.	Differences.
6231·64	$\frac{1}{30} \times 186947·65 = 6231·59$	+ 0·05
5498·28	$\frac{1}{34} \times 186947·65 = 5498·46$	+ 0·18
5193·25	$\frac{1}{36} \times 186947·65 = 5192·99$	+ 0·26
5052·53	$\frac{1}{37} \times 186947·65 = 5052·64$	− 0·11
4919·63	$\frac{1}{38} \times 186947·65 = 4919·68$	− 0·05
4248·08	$\frac{1}{44} \times 186947·65 = 4248·81$	− 0·73
4064·1	$\frac{1}{46} \times 186947·65 = 4064·1$	− 0·0

I have included the forty-fourth harmonic, because Thalén gives 4248·8 for the observed value of the wave-length, which reduces the difference to zero. I must, of course, complete the investigation before I can definitely say in how far all these coincidences may be due to accident. On the whole, as far as I have hitherto gone, the result does not seem to be decisive in favour of such a simple connection between the wave lengths of different lines. The true law of the distribution has not yet, I believe, been found, but harmonic ratios may take a secondary part. ARTHUR SCHUSTER

OUR ASTRONOMICAL COLUMN

PALISA'S COMET.—The following elements of this comet have been calculated by Mr. Hind from the first Pola observation on August 21, one at Leipsic on August 28, and M. Henry's observation at Paris on September 11:—

Perihelion passage, 1879, October 4·2871 G.M.T.

Longitude of perihelion	201° 41′ 52″·8	Apparent Eq. August 31.
,, ascending node ...	86 54 4·2	
Inclination	76 57 38·2	
Log. perihelion distance	9·9983406	

Motion—direct.

Positions deduced from these elements for midnight at Greenwich are:—

	Right Ascension. h. m.	Declination North. ° ′	Log. distance from Earth.	Log. distance from Sun.
Oct. 2	14 19·1	22 31	0·2044	9·9985
3	— 23·5	21 30		
4	— 27·9	20 30	0·2072	9·9985
5	— 32·1	19 29		
6	— 36·3	18 28	0·2106	9·9987
7	— 40·4	17 28		
8	— 44·4	16 27	0·2144	9·9995
9	— 48·3	15 27		
10	— 52·2	14 28	0·2187	0·0008
11	— 55·9	13 28		
12	14 59·6	12 30	0·2234	0·0027

On November 4·5 the right ascension is 242° 40′ and the declination 7° 6′ south, the comet setting in London two and a quarter hours after the sun; the intensity of light is then somewhat greater than at discovery, so that observations may be expected till about a month after the perihelion passage.

NEAR APPROACH OF COMETS TO THE EARTH.—Amongst the cases of close approach of comets to our globe there are two in which we are able to fix the actual degree of approximation with certainty, the orbits at the times having been determined with great precision. The first is that of the comet of 1770, treated of by Laplace in the *Mécanique Céleste*. According to Clausen's elaborate investigation, in which the effect of the earth's attraction is included, this comet at 5h. 6m. P.M. Greenwich time on July 1, was distant only 0·01509 of the earth's mean distance from the sun, or 1,390,000 miles, and it is the closest approach of one of these bodies of which we have any certain knowledge. On this evening its apparent diameter, as measured by Messier, was no less than 2½°, or nearly five times the apparent diameter of the moon; at this time the comet was traversing the constellation Draco. The second case is that of Biela's comet at its appearance in 1805. At 9h. P.M. on December 9, just before it descended below the horizon in Europe, and almost at the time of the last observation by Thulis at Marseilles, the comet was distant 0·0366, or about 3,380,000 miles. There can be little doubt that the comets of 568, 1366, 1472, and others passed near the earth, but the elements of their orbits are not determinable within anything like close limits. The first comet of 1743, for which Clausen assigned an elliptical object, was also near to us, but the orbit in this instance is doubtful, and the actual distance in perigee cannot be deduced with precision.

There have been many instances where comets at one or other node have passed much nearer to the *earth's orbit* even than in the case of the comet of 1770, as occurred with Biela's comet in 1839, but the nodal passages have taken place when the earth has been far removed from these points of her path.

BIOLOGICAL NOTES

THE "CHALLENGER" RHIZOPODS.—In the current number of the *Quarterly Journal of Microscopical Science* Mr. H. B. Brady, F.R.S., continues his very interesting preliminary report on the porcellanous and hyaline types of rhizopods met with in the dredged stuff brought home by the *Challenger* Expedition. He very justly abolishes the misleading generic names of *Tri-* and *Quinque-loculina*, agreeing with Prof. Williamson to employ the modified term *Miliolina* for the section. Quoting *Decaisnella*, M-Chalmas, as a synonym of *Dactylopora*, P. and J., he mentions that *D. eruca* occurs in considerable variety of form, but that after the examination of a large number of fresh specimens, he has never seen anything to correspond to the structures figured in M-Chalmas's paper in the *Comptes Rendus*—figures curiously enough reproduced in another portion of the same journal, in which Mr. Brady's paper appears. The species of *Lagena* found supply material, we are told, for five or six crowded plates, its varieties embracing modifications of contour and surface decoration before unknown and most remarkable for their individual beauty. The rare and interesting *Pavonina flabelliformis*, D'Orbig., has been taken at three of the *Challenger* stations; originally described imperfectly by D'Orbigny from a specimen from Madagascar in 1826, it remained unknown until dredged by Dr. E. Perceval Wright in shallow water near the Seychelles. Two excellent figures of it are given. A number of forms of *Globigerina* are described. *Hastigerina*, Wy. T., is referred to *Nonionina*, D'Orbig. The paper closes with some notes on "Pelagic Foraminifera," in which, "while without departing from an attitude of caution in accepting evidence upon a subject so beset with difficulties," the author confesses that he sees no anomaly in the supposition that organisms so simply constituted as this group of protozoa may be equally at home at the surface and at the bottom of the ocean.

THE "CHALLENGER" ECHINI.—Prof. Alexander Agassiz has just published a preliminary report on the echini of the exploring expedition of H.M.S. *Challenger* in the *Proceedings* of the American Academy (vol. xiv. p. 190, June, 1879). It was not Agassiz's intention to publish this preliminary notice, as he hoped to be able to issue the descriptions of the species with his final report on the group; he found himself, however, compelled for the sake of retaining for the material of the *Challenger* expedition the priority of discovery, to notice, however briefly, the magnificent collection of sea-urchins intrusted to his care by Sir Wyville Thomson. In contrasting this collection with those made during the two expeditions of the U.S. steamer *Blake*, Agassiz says that these latter contain some of the most interesting forms obtained by the former, often complementing more or less imperfect *Challenger* material. Among the Cidaridæ, Arbæciadæ, and Diadematidæ, many new species were found, and a new genus allied to Astropyga. Among the Echinothuriæ, a number of new species were dredged. Among the Echinometradæ nothing of importance was collected. Among the Temnopleuridæ excellent series of the species of Salmacis and Temnopleurus were obtained, a Cottaldia, hitherto only known from the chalk, and an exquisite genus Prionechinus, allied to Salmacis. The most interesting feature of the Echinidæ proper, was the occurrence of several northern forms in deep water in the tropics. Not a single new species of Clypeastroids was found, and the number of specimens even was quite small. They do not play any important part in shaping the character of the fauna of deep water, and are, perhaps, the most strictly littoral group of Echini, indicative at least, in the present epoch of comparatively shallow water, inside of the 100-fathom line, and probably giving us a good guide as to the depth of the sea and the nature of the bottom of the cretaceous and tertiary shores, where they occur in such large numbers. One recent species of Catopygus is interesting, as adding another of the cretaceous forms to those still living. By far the most interesting group of Echini is that of the Pourtalesiæ—the species were found in abundance; of Pourtalesia there are six species. In Cystechinus there are three species, *C. Wyvillii* and *C. clypeatus* have quite stout tests, while in *C. vesica* the test is reduced to a mere film, so that even in alcohol the shape of this sea urchin reminds one of the crown of an old felt hat which had seen its best days. The test of all the Pourtalesiæ is quite delicate, the amount of lime-

stone being, at the great depths where they occur, reduced to a minimum, and yet even at the greatest depths they are found associated with Ophiurans, which are by no means wanting in lime. Among the Euspatangia, *Spatangus purpureus* occurred in the tropics at a depth of 400 fathoms, and *Echinocardium australe* was dredged at the great depth of 2,675 fathoms. In Australia it is a littoral zone species. Among the Brissina two species of Hemiaster were obtained allied to *H. prunella*, a new species of Rhinobrissus, and two new ones of Schizaster. No better idea can be given of the value of this extraordinary collection than by stating that there are described in this list no less than forty-four new species. At the time of the publication of Agassiz's "Revision of the Echini," there were scarcely over two hundred species of Echini known, and since that time less than fifty species have been added to the list. In the specific diagnosis of the species only the principal localities are given; the full details are reserved for the full report, which we believe is in good progress, many of the requisite illustrations being already engraved.

ATLANTIC STALK-EYED CRUSTACEANS.—Mr. S. J. Smith, of Yale College, publishes, in the *Transactions* of the Connecticut Academy of Arts and Sciences (vol. v. part 1), an account of the stalk-eyed crustaceans of the Atlantic Coast of North America. This account forms part of the report in preparation for the United States Commissioner of Fisheries. It embodies the study of the extensive collections made during the past fourteen years by Prof. Verrill and himself. In the present paper only the species inhabiting the coast between Cape Cod and Northern Labrador are given, and although the paper has special reference to the geographical distribution of the species, considerable matter is introduced in regard to specific variation and specific characters, and under some of the species, to the synonymy, especially where it seemed necessary to the proper understanding of the geographical distribution, or to show the propriety of the nomenclature adopted, or where the species is not well known. The total number of species recorded is 73, of which 45 are Decapods, 11 Schizopods, and 17 Cumaceæ, one-half of which are also to be found in Europe, the author concluding that there is not only a close relationship between the marine fauna of Greenland and that of Northern Europe, but a similar close one between that of Greenland and of the coasts of the continent of North America.

LAND-SHELLS OF CALIFORNIAN AND MEXICAN ISLANDS.—In a short paper in *Proc.* Acad. Nat. Sci. of Philadelphia for 1879 (p. 16), Mr. W. G. Binney gives an important contribution to the geographical distribution of land-shells. The Mexican island of Guadelupe, 220 miles from San Diego, off the west coast of Lower California, has been visited by Dr. E. Palmer, and he found numerous fragments of snail-shells which had been devoured by a species of mouse, the only land mammal on the island. These appeared to belong to *Arionta rowelli* (Newcomb), found in Lower California. *A. facta* occurred, a variety with open umbilicus, like that found fossil on San Nicolas Island, California. Living specimens of *Binneya notabilis* were brought from Guadelupe, found also on the Californian island of Santa Barbara; it is very nearly allied to if not synonymous with the Mexican genus *Xanthonyx*. Thus it is supposed to have been first distributed from Mexico, then to Guadelupe, thence to Santa Barbara.

NEW GENUS OF FISHES APPROXIMATING TO THE MACKEREL.—In the San Francisco market a fish is often exposed for sale, having a long body, with more than seven finlets behind dorsal and anal fins, the body having long narrow scales on region behind the eye, on each side of the dorsal outline, and on base of tail; the rest of the body is bare of scales. It has no corselet, and no teeth on vomer or palatines. There are fifteen dorsal spines, very fragile and slender. The ventral fins are very small, the colour is dark steel blue above, silvery below; and there are no streaks. The length of a specimen described by Mr. Lockington (*Proc.* Acad. Nat. Sci. Philadelphia, 1879, p. 136) was 21 inches to end of middle rays of caudal, length of head $4\frac{1}{4}$ inches, greatest depth of body $4\frac{1}{8}$ inches, length of pectoral fins $2\frac{5}{8}$ inches, ventrals 1 inch.

HAIR-WORMS.—Curious knotted masses of hair-worms (Gorduis) are sometimes found in gutters after rain. Prof. Leidy disentangled one such mass last winter, containing fifty-two males and seven females; the former were from 8 to 25 centimetres long, and from one-half to two-thirds of a millimetre in thickness; the latter from 14 to about 20 centimetres long and 1 millimetre thick. These worms are very lively; and when disentangled soon become again aggregated with the heads external and divergent.

PROF. MARSH, when examining recently the Rocky Mountain deposits known as the Atlantosaurus Beds, was rewarded by the discovery of the lower jaw of a mammal, a diminutive marsupial (somewhat smaller than a weasel), differing widely from any living type. The remarkable feature in the jaw is the series of premolar and molar teeth. The nearest affinities of this mammal are with the genus *Stylodon*, of Owen, from the Purbeck beds of England. Prof. Marsh designates the new genus *Stylacodon*, and the species represented *S. gracilis*.

GEOGRAPHICAL NOTES

AT the meetings of the International Geodetic Association at Geneva the representatives of the various countries present reported on the works executed by their governments. We are pleased to learn of a resolution of the French Ministry to proceed to a new levelling of precision of the first order on a length of 17,000 kilometres; a levelling of the second order will follow on a length of 800,000 kilometres. The operations to connect Spain and Algeria, to which we have referred were also described. The next meeting will be held at Munich in the autumn of 1880.

A TELEGRAM from Samarkand to the Russian papers, informs us that the expedition for the tracing of a railway from Karaturghel to Tashkend and Samarkand has finished its explorations. It has explored the banks of the Syr-daria in the neighbourhoods of Kara-Uzyak, the coal-mines at Khojent, and the moving sands of Fergana, as well as a part of the Surkhan river and the roads from Samarkand through Djam-Karshee and Kitab-Shaar to the Iron Gate, and thence to the ruins of Termez on the Amu-daria. Throughout its route the expedition has made astronomical, meteorological, geological, botanical, and zoological researches; now it is engaged in a hydrographical description of the Amu-daria and of its delta.

THE Russian Government are actively pursuing the exploration of the great rivers of Russia in Europe. Thus, during the last three years the Volga was surveyed on a length of 775 miles; a thorough levelling is completed on 300 miles, and no less than 91,720 soundings give the necessary data for preparing a detailed map of the river. The Chussovaya river, one of the upper branches of the Kama river, has been explored on 270 miles, and the Byelaya, the other branch, on 160 miles. The Vyatka river is thoroughly surveyed and levelled. The description of the Vistula is quite completed. Extensive surveys and levellings were made on the river systems of the Dneiper and Bug, as well as on the Don, which is surveyed on a length of 560 miles. New surveys were undertaken last year on the Northern Drina and Sukhona, as well as in the basins of the Obi and Yenissei. Several stations were established for

observations on the changes of levels of rivers, as well as for meteorological observations and for weather-warnings.

THE official Report on the Forests in the South and West of the Island of Cyprus, by Mr. A. E. Wild, of the Indian Forest Department, goes far to explain the unhealthy climatic conditions now existing in the island, and of which so much was recently said. In the region named the forests are now mostly confined to the chain of hills running east and west, and even there the more dense and better growth is confined to the more inaccessible spots of the higher ranges. Round the villages and in suitable localities for transport the forest is already so thinned as to be unworthy of the name. This unfortunate state of things, which has had a serious effect on the climate, has been brought about by the most reckless improvidence in the felling of trees, aided by fires and the ruinous mode of extracting resin. Mr. Wild appears to be of opinion that by a careful system of forest preservation, which need not involve us in a large expenditure of money, the damage caused under the Lusignan and Turkish rule, may be to a material extent repaired in the course of fifty or sixty years.

M. E. F. BERLIOUX, Professor of Geography at Lyons, has just issued a second edition, revised and enlarged, of his *brochure*, entitled "Les Anciennes Explorations et les Futures Decouvertes de l'Afrique Centrale," which is illustrated with a curious map of the northern portion of the continent.

A PARTY of forty-seven persons, amongst whom there are twelve married couples, and fourteen children, sailed last week from Bergen (Norway), with the intention of colonising the Aldabra Islands in the Indian Ocean (in about 9° lat. S. and 46° long. E.). The idea resulting in this undertaking was first conceived by two Norwegians, who had repeatedly visited Madagascar, where they had learnt that the Aldabra Islands are uninhabited at present, and excellently adapted for colonisation.

MUCH attention is just now being attracted in Queensland to the proposed scheme for a Transcontinental railway to Port Darwin on the northern coast, of the suggested route for which a flying survey has recently been made by Mr. Faveuc and a party who started from Blackall, in Queensland. The present idea is to commence the line at Roma on the existing system, whence it would be taken by way of Blackall to the South Australian frontier, a distance of 750 miles. From that point it would still follow a north-westerly direction to Port Darwin.

A MEMBER of the Japanese mission now at the capital of Corea writes to the *Osaka Nippo* that the new ports, which it is proposed to open in that country, are Jin-sen, in Kei-ki-dō, and Gen-san, in Kan-kiyo-dō, the former of which is only eight *ri* distant from the capital. A Japanese surveying officer has also been engaged in making investigations at the port of Dai-on, in Kei-ki-dō, about eighteen *ri* from the capital, along the road to which there are many royal tombs. Partly on this account, and also because the road is considered a very important one, the Coreans for some time obstinately refused to permit the surveying officer to travel over it; eventually, however, they gave way. Great benefit, it is thought, would accrue to commerce if this overland route were opened. The Corean capital numbers among its residents many nobles and wealthy men, and several of the latter, who hold progressive ideas, are said to have ordered European articles at the open port of Fusan in the south. When the port of Jin-sen comes to be opened, it is believed that foreign merchandise will be in great demand.

OFFICIAL statistics respecting the population of Netherlands India at the end of 1876 have lately been issued, from which it appears that exclusive of the army, there were then in Java and Madura 18,515,414 people, being an increase of about 170,000 over the previous year. The natives figure for 18,278,998, of whom 8,921,348 were males, while the remainder is made up of Europeans, Chinese, Arabs, and other foreign Orientals, the Celestials being, of course, in a large majority. This remark also applies to the other possessions in Netherlands India, including Sumatra, Celebes, &c. Owing to the incompleteness of the returns of natives in these islands, no estimate of their total population can be arrived at.

WILLIAM WILSON SAUNDERS

WILLIAM WILSON SAUNDERS, F.R.S., F.L.S., &c., who, as we stated last week, died on September 13, was born June 4, 1809, the son of the Rev. James Saunders, Vicar of Kirtlington. He was educated at Addiscombe, and went to India as an engineer officer in the Hon. East India Company's service. While there he published his first scientific paper, in *Gleanings in Science* "On Hydraulic Cements," in 1831, and also devoted a great part of his leisure to the study of plants and insects, and made collections, which he brought back with him in 1832. Having left the service, he settled at Wandsworth, and shortly after joined his father-in-law in business at Lloyds, still continuing his natural history studies. He was one of the original members of the Entomological Society, and read his first paper, "On the Habits of some Indian Insects," in April, 1834. This was followed by many others, mostly of a descriptive nature. He was President of the Society in 1841, 1856, and 1857, and many times served as vice-president. He was also elected a Fellow of the Linnean Society in 1833, and was vice-president from 1856 to 1874, and treasurer from 1861 to 1873. He became a Fellow of the Royal Society in 1853, and was also a Fellow of the Zoological Society and Royal Horticultural Society, and on the Council of the latter he took an active part. His natural history collections gradually increased in extent from the time of his return from India, and he devoted himself principally while at Wandsworth to horticulture and entomology and to the formation of an extensive herbarium and collection of woods, with notes of the density and weight per cubic foot of each, which latter was exhibited at the great Exhibition of 1851. The Report of the Juries for the Exhibition gives a classified catalogue of them, with remarks as to their uses, &c.

In 1857 he went to reside at Hallfield, Reigate, and removed there his various collections, largely extending them, and adding collections of birds, shells, vegetable products, &c. His attention, however, was always mainly given to horticulture and entomology, and especially to the study and cultivation of the aloes, Crassulaceæ, Cacti, and other succulent plants which could not be duly studied in an herbarium, and to the smaller and more obscure species of orchids; and it was to bring these interesting and curious plants more prominently before the botanical world that he resolved on the publication of the "Refugium Botanicum," the first number of which appeared in April, 1868. In this work he had the valuable assistance of Prof. H. G. Reichenbach for the descriptions of the orchids, and of Mr. J. G. Baker, of Kew, for the other families, the plates being chiefly from the drawings of the well-known botanical artist Mr. Fitch, although some were from drawings of his own. The Fungi also attracted a good deal of his attention, and he made a series of very accurate drawings of all he was able to obtain, some of which have been reproduced in the "Mycological Illustrations," edited by him with the assistance of Mr. Worthington G. Smyth and Mr. A. W. Bennett; the first part of this appeared in 1871. Unfortunately neither the "Refugium" nor the "Mycological Illustrations" have ever been completed.

His entomological collection included insects of all orders, and though perhaps he gave more special attention to the Lepidoptera and Coleoptera, he was always

anxious to get together all the curious and striking forms he could, and his collections of Orthoptera, Hymenoptera, and Hemiptera were probably among the most extensive known.

Throughout his life he made copious notes and drawings of any natural curiosities that came under his notice, and kept a regular record of the rainfall and other meteorological occurrences. The care of all his collections, &c., occupied so much of his time that he had little left to devote to literary work, but he always allowed free access to the collections to any who were working and might benefit from them. At Reigate he started the Reigate Natural History Club, of which he was president for many years, and which still flourishes.

He left Reigate on account of business difficulties in 1873, and his collections were sold and dispersed. He then went to Worthing, where he resided till his death, having again surrounded himself with all the interesting plants, insects, &c., that he could get together.

TAILS[1]

II.

ANOTHER animal, the tail of which is remarkable for its mass of hairy covering, is the great ant-eater. But much more renowned is the yak, the tail of which animal is carried before dignitaries in Central Asia as an ensign of honour.

Such, then, are some of the main peculiarities of the tail in beasts. It is generally long, but may be absent altogether. It is generally hairy, sometimes very hairy, but it may be naked. It attains a prodigious size in exclusively aquatic forms, and in less aquatic forms—like the otter—it is largely developed, and somewhat flattened laterally, to aid the body in swimming.

Let us now consider the tail of a bird, and contrast it with that of a beast.

Every one knows that many birds are spoken of as having long tails, and so they have, in a sense. But a glance at the skeleton shows that it is not in the *same sense* that a bird and a beast are said to be "long-tailed." The bones of a bird's tail are few in number, and short, so that the tail is always very short as regards its bony portion, and also as regards the muscle and skin which covers it. At its end is a more or less conical or "ploughshare-shaped" bone, made of several vertebræ, which have coalesced together. Into the skin, which invests this short tail, are set the more or less long tail feathers, which form what we ordinarily call "the tail" of a bird. On the upper surface of the fleshy tail birds also carry a sort of natural pomatum-pot. It is a grease-secreting gland, especially developed in water-birds, which may constantly be observed rubbing their bills first upon this region and afterwards over the feathers of their body, in order to give them a coating of this natural unguent. It is the presence of a good supply of this coating which renders the feathers of aquatic birds so impervious to water as to cause it to be thrown off with a readiness which has given rise to the familiar saying "like water off a duck's back."

All birds without exception which now live, have but a short tail—in the true sense of the word—however long may be the *feathers* which clothe that tail. But it was not always so. A very ancient fossil bird has been (a few years ago) discovered in the Solenhofen slate of Germany. This fossil proves that in the secondary period, birds existed quite like our present birds in general appearance, and in the main details of their structure, but with a tail formed of a number of vertebræ of considerable length, like the tail-vertebræ of a long-tailed beast or (as we shall see) lizard. On each side of this tail were set feathers, so that altogether the structure was like nothing which is to be seen in the world about us to-day.

[1] A Davis lecture recently delivered at the Zoological Gardens by Prof. St. George Mivart, F.R.S., V.P.Z.S. Continued from p. 512.

This bird was the renowned *Archeopteryx.*

FIG. 5.—The Archeopteryx (of the Oolite strata).

But apart from such old-world wonders as this, what we call a bird's "tail"—meaning thereby the long feathers of the hinder part of its body—does not always denote really the same part.

The true "tail" of a bird (in this sense) means the collection of more or less strong and more or less elongated feathers which are implanted into the skin investing its short bony tail.

Of this nature is the tail of an eagle, of an ostrich, and the longest of all such tails—the enormous tail of the beautiful Reeve's pheasant. You will naturally wonder why I do not include that most wonderful and magnificent object, the "tail" of a peacock. I do not include it for the simple reason that this so-called "tail" is not a tail. Not a "tail" in the sense of a beast's tail, or that of the archeopteryx; not a "tail" in the sense of an ordinary bird's tail, *i.e.*, it is not made of feathers implanted into the short fleshy tail.

The feathers of birds are classed by ornithologists in different groups according to their position on the body, and to each such group is given its own special name. Thus the long feathers implanted into the side of the arm and hand (by which long feathers birds fly) are called naturally "wing-feathers," but there are other feathers implanted in the body at the root of the arm, and which so lie that they cover over and protect the roots of the wing-feathers. These root, or covering, feathers, which are comparatively short feathers, are called *wing-coverts.* Just in the same way, there are ordinarily short feathers implanted in the hinder part of the body, which short feathers cover and protect the roots of the tail feathers. They are therefore called *tail-coverts.*

Now the magnificent plumes of the peacock are not tail feathers, they are *tail coverts*, enormously enlarged and greatly exceeding in size the true tail feathers.

You may have observed a peacock setting up its so-called tail; if not, take the next opportunity of observing it. You will see that these very long and delicate plumes are lifted up and sustained by means of certain short and stiff feathers, and if you get behind the animal, you will see these latter feathers, which can be erected and so prop up and support the great mass of long, radiating tail-coverts. These short, rigid feathers are the true tail feathers, and thus in truth the peacock has a short tail, not only as regards the skeleton, but also as regards the true tail-feathers, in spite of the length of that magnificent appendage which usage will force us still to call the peacock's "tail," even after we have made acquaintance with its real nature. Indeed it would be a piece of pedantry to call it anything else; but yet we may bear in mind, when we do call it tail, that we do not here denote by that word the same structure as we denote when we speak of the "tail" of ordinary birds.

This condition is not peculiar to the peacock, though it is the most striking instance of it. In such kinds as the grouse the tail is in large part formed by tail-coverts.

The "tail" of the lyre bird, on the other hand (the "lyre" being formed by the external thick and gracefully curved feathers, with delicate string-like feathers between) is a true tail, and its feathers are implanted around its bony tail.

It may be mentioned in passing that we sometimes meet with an analogous elongation of feathers of other parts of the body which are usually short. The beautiful and delicate plumes of the ordinary birds of paradise—those "crows" of Eden, for they are only kinds of crows after all—are made of exceedingly elongated axillary feathers, which in length greatly exceed the wings themselves.

To return, however, from wings to tails: the tails of birds, whether long or short, or whatever their nature, never serve the purpose which the tail serves in many beasts, and which we shall hereafter find reason to think was the very original purpose of "tails" when they first came into the world.

No bird swims by its tail. Birds, such as swans and ducks, swim by the paddling action of their feet. The most aquatic of all birds, the penguins, swim by the strokes of their wings, clothed with scale-like feathers—for the penguins may be said to fly under water. Whether any ancient aquatic bird once existed with a long tail like the archeopteryx is doubtful, but if it did, it is hardly likely that such an organ acted as a swimming organ. For to be able so to act, it must have been muscular, and therefore both thick and heavy, and therefore a fatal encumbrance to a creature destined for flight. If it were so furnished, and was destined never to fly, but to paddle like a penguin, in addition to propelling itself by lateral or vertical blows of a long and thick tail, then such a bird would be one difficult indeed for us to picture to our imaginations—though of course not outside the bounds of possible existence.

Let us now pass from considering the tails of birds, to a review of the tails of reptiles. In this matter we find a return to conditions we have made acquaintance with in beasts.

All living birds have tails which, as regards their bones, flesh, and skin, are nearly alike, but reptiles (like beasts) may have tails which are either long or short, according to their kind. We also here again meet with a "prehensile tail" like that of the kinkajou, or spider monkey. We find such a prehensile tail in the chameleon.

The chameleon is a creature destined to live on trees, and has its hands and feet modified into so many two-pronged grasping organs, to take a sure hold of the twigs and branches. It is a very slow animal, exceedingly deliberate in its motions, and did its hold partly fail, it would be incapable of rapid and sudden movements to save itself from falling, by a sudden clutch at some new point of support. Accordingly, it has an extra chance given it by its tail, which, tightly grasping by its curled end, gives the animal the advantage of what is practically a fifth limb.

Strange to say, though, it is not quite every kind of chameleon thus provided. There are many known kinds, and all but one have prehensile tails. One kind, however, not long ago described by Dr. Günther in the *Proceedings* of the Zoological Society, has a short tail, altogether destitute of any power of grasping. The tail, therefore, is useless to it as a prehensile organ, but instead it has, by way of compensation, serrated claws, which other chameleons have not.

The tail of the crocodile is a prodigiously powerful and very long one. It is thick, containing voluminous muscles, by the action of which this animal not only swims with facility, but when on land is able to deal terrible blows. Indeed lizards, with tails which are slender in comparison with the crocodile's tail, are yet able to deal powerful blows and to inflict whip-like cuts by means of lashing their long, rough-skinned tails. I am again indebted to Mr. Bartlett, for a note on this subject. He tells me that he found the large lizard called the Egyptian Monitor do this when lively and in full condition.

Most of my male hearers have, no doubt, when attempting to catch by their tails one of our little English lizards, been surprised to find the animal run away, leaving its tail behind in their grasp, and seeming none the worse for its sudden loss. The tail left behind will twitch and move about in a lively manner for a considerable time, especially on a very hot and sunny day.

This loss, which the animal so readily undergoes, is not, however, a permanent one. A new tail soon begins to sprout, and before very long an ordinary observer could not tell this new tail from the old one, although in the details of its structure it is not quite the same. The power of repair in these animals' tails may be shown in other ways. If the tail happen to be divided not transversely, but longitudinally, each such half will become an entire tail, when the process of reparation is complete; then, if each of the new tails be again longitudinally divided, each such new division will again become entire, and the process has been repeated till the lizard operated on came to have as many as sixteen tails, side by side.

The tails of lizards are most various in shape, although mostly long, and sometimes exceedingly so; there are what are called "stump-tailed lizards," as in the adjoining house at this moment. Some Australian lizards have short and flattened-out tails of exceedingly odd appearance, the utility of which it is hard to conjecture.

Snakes may, in spite of their always long bodies, have short tails, while in some kinds the tail is exceedingly long.

I have in this bottle a real "sea-serpent." Do not imagine, however, that it is the young of the renowned animal of our newspaper correspondents. That animal, if really any one animal at all serves as the foundation for these travellers' tales, cannot be a serpent. This creature, however, is a true sea-serpent—and a poisonous one to boot—and many such of various species are found in the waters of the Indian Ocean.

They exhibit a remarkable adaptation to their aquatic life, in that their tails are flattened laterally so as to fit them the better to serve as swimming organs, like the tails of fishes.

Some small serpents which burrow in the ground (*Typhlops*), and some legless lizards (*Amphisbæna*) of similar habits, have very short tails, while the two extremities of the body become strangely alike in appearance.

Other small burrowing serpents have the tail ending in a flattened disk, just for all the world as if a portion of it had been cleanly cut off and had then skinned over. The use of this structure is problematical.

My friend Dr. Günther writes to me on this subject:—"I have often thought of the use of the rough tail of the *Uropeltidæ*, and believe that it is used either for burrowing in the soil during a backward motion of the animal (like the roughness on the shell of some burrowing mollusks); or for affording to the animal, whilst it is burrowing in a forward direction, a firm support on the smooth surface of its burrow. It may be of use in both ways."

Most renowned of all serpents' tails, and justly so, is the tail of the rattlesnake. This organ consists of a thickening of the outermost skin (or *epidermis*) which invests the end part of the tail. The thickening takes the form of a series of rings, which encircle the tail, and of course diminish in size as they approach the tail's end. By a rapid vibration of the tail these thickened rings of horny substance (for epidermis has the nature of horn) strike one against another, and produce a very peculiar noise, which may occasionally be heard in our reptile-house, and is heard when the rattlesnake is alarmed or excited.

Thus the "rattle" of the poisonous rattlesnake (like the expanding hood of the poisonous cobra) must tend to act as a warning to creatures exposed to its attack. It is very difficult to see what service this rattling can do to the rattlesnake itself. It has indeed been suggested that the sound resembles running water, and that in this way

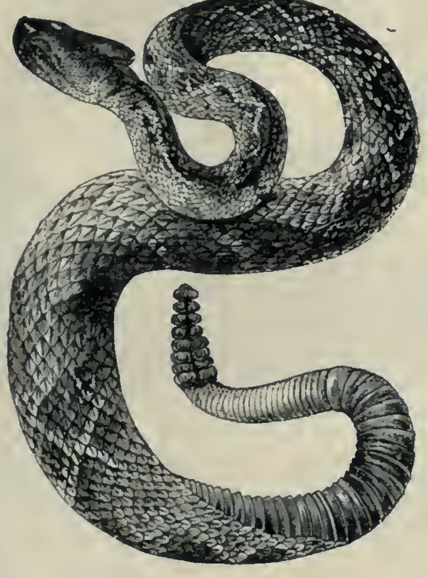


FIG. 6.—Tail of Rattlesnake.

creatures may be attracted to its vicinity. I must say that I for my own part have never been able to detect any such resemblance. Moreover, to have such an effect the rattling should be long-continued, whereas it is, in fact, kept up but for a short time, and is only produced at comparatively rare intervals.

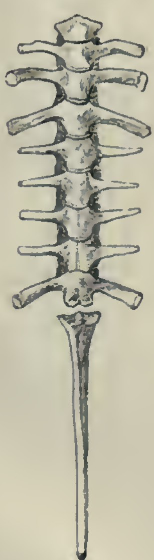


FIG. 7.—Backbone of the Frog (ventral aspect).

FIG. 8.—Backbone of the Frog (dorsal aspect).

Below the great group of reptiles is another group of animals, at one time associated with them, but now recognised as having a greater affinity with fishes. The group of animals I refer to is that which is made up of frogs and toads, together with efts (or newts), which latter are such familiar objects in our ponds in the spring of the year.

The efts have all long tails, but the frogs and toads are fully as destitute of a tail as we ourselves are, though they have a long slender bone at the hind end of their vertebral column, which bone reminds us of the ploughshare-shaped bone of birds. But you may recollect that this tail-less condition, even in ourselves, does not obtain in the very earliest stage of the human body. In frogs and toads a "tailed" condition endures much longer; for these animals, as you know, pass the first part of their life entirely in the water as "tadpoles," swimming about entirely by the undulating action of their long "tails." The tadpole is at first a singular object. It consists of a head and body indistinguishably united in one rounded ball, from behind which a long and slender tail projects. The creature may be said to be indeed at first "all head and tail," for its head is relatively very large, and the heart and other organs may almost be said to be included within it.

FIG. 9.—Tadpoles in different stages of development, from those just hatched (1) till the adult form is attained (8).

Whatever may be the best way, however, of regarding its head, there can be no doubt about its tail, its function, or its fate. It is, as I have said, a swimming-organ, but you know that as the tadpole becomes a frog or toad, it either comes on land or swims in quite another fashion from what it does as a tadpole, usually by striking out with its legs and feet, just as we swim, only it does it much better. Thus the tail becomes a superfluous appendage, and indeed as the limbs grow, the tail is gradually absorbed. It is not cast away! Our popular novelist was wrong in writing "What next! as the tadpole said when his tail dropped off;" it does not "drop off," but is sucked up by the creature's body gradually. Indeed the animal feeds upon its tail, not by turning round, biting, and eating it, but by its substance being gradually taken up and absorbed by the blood-vessels, and carried elsewhere, to assist the processes of bodily growth and development which are rapidly taking place.

Tadpoles and efts lead us naturally to the last and lowest class of backboned creatures the class of *Fishes*.

As these animals are all aquatic, so they all have more or less long and powerful tails. Almost always they swim by striking the water right and left with the tail, and as they breathe by gills, without coming to the surface, so the tail and its hinder end are flattened from side to side, and not from above downwards, as we have seen to be the case with the air-breathing whales and porpoises.

Some fishes, however, progress largely by means of great lateral fins, as is the case with the rays, or skates, and in them the tail is comparatively small.

There are certain fishes which go by the name of *Sea Horses*, though they are but small creatures. These fishes swim through the water in a remarkable way. They appear as if they glided at will without effort. But there is on the back a small fin, which by its constant undulations acts like the screw of a screw-steamer. It is by this the creature moves, and the long tail takes no part in such progression, and is relatively thin and small, except as to its length.

In this tail, however, we find once more that prehensile character, such as we saw in the chameleon, the kinkajou, and others. The sea-horse anchors itself by clinging with its tail round sea-weed, or some similar object, much as do the animals mentioned.

The tails of fishes are like those of beasts and reptiles, supported by an extension of the back-bone, and, as a rule, contain no body-cavity. But the mode in which the vertebral column ends varies in different fishes in a way worthy a passing mention.

In such a fish as the sturgeon the end of the tail is furnished with a fin, divided into two unequal lobes. The end of the vertebral column runs along in the upper lobe, but there is nothing similar in the lower lobe, so that the lobes of the tail are very unequal, not only in size, but also in structure. The tail-fins of sharks are similarly conditioned. In such a fish as the cod-fish, on the other hand, the vertebral column seems to stop short in the middle between the two lobes of the tail, which lobes are equally developed.

This difference may seem trivial, but, in fact, it is characteristic, not only of different groups of fishes, but of fishes of different geological periods. The unequal tail end is the more ancient, and has gradually given place to the other apparently quite symmetrical form. I say apparently, because, in fact, when the symmetrically formed tail is minutely examined, it turns out that even here, the end of the vertebral column is turned up, extending dorsally as in the sturgeon and sharks. But it is only a minute portion which is thus turned up. However, it *is* turned up, and very strongly so, and thus the curious fact of the upward inclination of the tail is seen to be a general character of fishes, whether their tail-fins are apparently symmetrical or not.

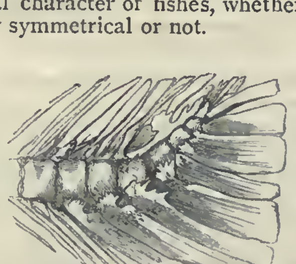


FIG. 10.—Post-axial termination of the vertebral column in a salmon.

Such are the main varieties of tail which are to be found in back-boned animals, that is to say, in beasts, birds, reptiles, frog-like creatures, and fishes; and thus we see that one general structure underlies the various varieties of external appearance which the tails of such creatures may present.

But there are many creatures of quite different nature and build, which are said to have "tails." Thus, for example, we speak of the "tail" of a lobster, or the "tail" of a scorpion.

Now, of course, I do not mean to assert here, any more than I asserted about the feathery so-called "tails" of birds, that you should depart from ordinary usage. Still, the so-called "tail" of such animals is really utterly unlike the tail of back-boned creatures, and is, in fact, but the backward prolongation of the body.

The lobster's body is made up of a series of more or less similar segments, in great part more or less agglutinated together. It contains a body-cavity which is traversed by the alimentary canal. The so-called "tail" does not differ from the lobster's body as the tail of a cat differs from the cat's body. For the tail of the lobster is also composed of a series of similar segments, also contains a body-cavity, and is also traversed for its whole length by the alimentary cavity—that is, by the intestine. The same is to be said with respect to the so-called "tail" of the scorpion, which, although so much more slender than the so-called tail of the lobster, is no more really a "tail" than is the latter.

We see, then, that the word tail in its proper signification means the prolongation backwards of a backbone (with the soft structures which surround it) beyond the body-cavity and behind the posterior end of the alimentary canal. This is the strictest meaning of the word "tail."

But other structures which, by their position, posterior extension, slenderness, or some other analogical resemblance, more or less resemble what is most properly and strictly called a tail, have the same term also applied to them.

While freely adopting popular usage in this matter, and calling, without scruple, by this term whatever is commonly and generally so termed, it is none the less well to bear in mind the differences which have been here pointed out as existing between the various more or less different structures which are thus spoken of by one common term.

The survey we have made has also another result. Different organs have not only their proper forms and structures, but also their proper uses.

The uses to which we have seen that tails are applied are more or less varied. Sometimes, indeed, the tail may serve as a fifth hand, as in the spider-monkey; but tails are generally related to locomotion, or at least to the balancing of the body, and prehensile tails are important aids to safe locomotion, especially in climbing.

But tails are most generally and largely developed in the class of fishes, and altogether the most effective aid to locomotion which tails offer is the aid they give in swimming. As, then, the essential structure of a tail is a backward prolongation of the vertebral column without any body-cavity, so the essential and fundamental *use* of a tail seems to be to act as a swimming organ. As the class of fishes seems to have been the first class of back-boned animals to come into existence, so we may deem it probable that a tail first appeared as a swimming organ added to a body in front of it, somewhat, perhaps, as we find the tail of our existing tadpoles.

This matter, however, is but one of speculation. But the world around us, as it exists now, affords us many examples of beautiful adaptation and utility in the structures in the examination of which we have been concerned to-day. The perfection of the hand, the varied adjustments of limbs, the wonderful complexity of the head, are matters for which every one would of course be fully prepared. But our survey may perhaps have sufficed to show that utility, beauty, and adaptation are exhibited to no small extent by organs the structures and functions of which are so rarely treated of and so slightly noticed as those with which we have been occupied, namely, the organs called "tails."

THE ALGERO-SPANISH TRIANGULATION

WE have received from Algeria further details as to the execution of the triangulation of the Algero-Spanish geodetic arc. The stations in the Algerian province of Oran are Msabia, a farm held by a colonist in the Mordzago at an altitude of 585 metres, and Mount Filhaoucen, at an altitude of 1,100 metres in Traras. These stations are at a distance of 108 kilometres from each other. The Spanish engineers have located themselves at Mulhacen, 3,500 metres altitude, in the Sierra Nevada, and Tetica, in the province of Murcia, 2,400 metres altitude. The distance from Tetica to Mulhacen is 88 kilometres. The two lines, Msabia-Tetica and Filhaoucen-Mulhacen, are respectively 270 and 300 kilometres long. In day-time signals were exchanged by sunlight and reflected by silvered glass mirrors 30 centimetres diameter; at night a Gramme electric machine was used in each station and worked by steam engine. The mirrors used for the electric light are 50 centimetres diameter. A telegraph line has been established from Oran to Msabia, a distance of 16 kilometres, so that Msabia is placed in direct communication with the European system. The temperature of the Spanish stations was very low, and fell several degrees under zero, while the heat was very great in the Algerian stations, which must be taken into account in the calculation of atmospheric refractions. Colonists and especially Arabs showed much surprise at seeing their mountains illuminated by a powerful ray of light which the French officers were sending from Filhaoucen and Msabia in the interval of operations. They were heard to say that the French had inherited the power of Allah, as they were making suns and stars.

THE IRON AND STEEL INSTITUTE

THE annual autumn or country meeting of this Association was held last week at Liverpool, in the concert room of St. George's Hall, the proceedings being opened with a few hearty words of welcome from the Mayor. The report of council showed that the Institution continued to flourish in spite of the hard times in the trade, fifty-eight new members having been added to the list on the last ballot and the proposal papers of thirty-eight received. The President then announced that the Council had accepted an invitation, numerously signed by representative firms in the iron trade of Westphalia to hold the autumn meeting of 1880 at Düsseldorf, which proposal was unanimously confirmed by the meeting.

After the completion of the formal business, the proceedings commenced with a discussion on the very useful method of determining manganese in iron ores, spiegel, ferromanganese, &c., by the volumetric method described by Mr. Pattinson, of Newcastle, at the last meeting in London, and which, according to the generally expressed opinion of chemists present, seems destined, for commercial purposes at any rate, to take the place of the more tedious analytical methods now in use.

Among the new communications prominence was given to a paper by M. A. Pourcel, of Terrenoire, on the causes of dephosphorisation of iron and steel, the principal idea in which was that the amount of phosphorus reduced from phosphates contained in iron ores depends mainly on the temperature and not on the reducing energy of the furnace temperature, instancing the fact that from the same ores pig-iron containing phosphorus in proportions varying from 1 to 3 might be obtained in the blast-furnace, according as the coke charge in the furnace was heavily burdened or not, a conclusion that did not find much favour among the members present.

A second paper on the neutralisation of phosphorus in iron and steel, by Mr. Richard Brown, of Ayr, proposed the addition of small doses of bichromate of potassium to the metal in the converter or melting furnace in order to introduce a small proportion of chromium into the finished steel. According to the author's statement, metal with from 1 to 1½ per cent. of phosphorus may be made to show fair working qualities, when containing 0·1 to 0·2 per cent. of chromium as a corrective, but from the results of the tests produced in support it appeared to be extremely irregular, as regards extension under strain. In the discussion on this paper some interesting remarks were made incidentally by Mr. Riley on the working of a chromiferous pig iron, which was made to some extent in Tasmania, and from which great things were expected, but it had been found impracticable to produce clean iron from it in the puddling furnace, owing to the refractory character imparted by the chromium to the slag. Another paper by Mr. Bull reproduced the old idea of dephosphorising by means of steam, but no very new facts appear to have been brought forward by the author. A useful method of compressing the tops of steel ingots by the direct action of high pressure on the surface of the molten metal, invented by Mr. H. R. Jones, of Pittsburg, Pennsylvania, was described by Mr. Davis. This appears to mark a real progress in the manipulation of the metal, as the proportion of unsound ingots is said to be notably reduced by its use. Of more general interest than the formal papers, however, was the statement made by Mr. Windsor Richards, on the progress achieved in the dephosphorising of Cleveland pig-iron in the Bessemer converter by the Thomas-Gilchrist-Snelus process since the last meeting, which Mr. Bell pronounced to be an absolute scientific success, steel rails produced by this method at Eston from Cleveland ore having satisfactorily passed the tests prescribed by the North-Eastern Railway Company. Several minor papers less intima ely connected with the main objects of the Institution, such as the use of glass toughened by Siemens's process of annealing for tramway sleepers, the progress of iron and steel as constructive materials were also read during the meeting. The afternoons, in accordance with the usual custom, were devoted to excursions, the members being fortunate enough to have the three finest examples of the Transatlantic steamers belonging to the Cunard, Inman, and White Star Lines in port and available for their inspection at the same time. The Warrington Wire Works, the largest manufactory of the class in the country, the enormous locomotive engine, boiler, and steel works of the London and North Western Railway Company at Crewe, Messrs, MacCorquodale's Railway Printing Office, and several of the large collieries in the Wigan district were also inspected by the members on the remaining afternoon of this very successful meeting.

NOTES

THE Autumn Congress of the Sanitary Institute will be held at Croydon from the 21st to the 25th inst., under the presidency of Dr. B. W. Richardson. The exhibition will be opened at 3 P.M., on the 21st, and in the evening Dr. Richardson will give his presidential address. On the 22nd Dr. Alfred Carpenter will give the address in the Section of Sanitary Science and Preventive Medicine; on the 23rd Capt. Douglas Galton, in the Section of Engineering and Sanitary Construction; and in the evening Prof. Corfield will give a lecture to the Congress; on the 24th Mr. G. J. Symons will give the address in the Section of Meteorology and Geology. Saturday, the 25th, will be devoted to discussion. The results of the examinations conducted by the Institute having shown the necessity for some systematic plan of technical instruction in sanitary science, the Council have decided to establish a School of Hygiene in London, to be opened during the month of November next. The course of instruction will include the following subjects:—Preventive Medicine. Practical Sanitary Science—(*a*) Medical and Chemical; (*b*) Engineering and Constructive. Jurisprudence and Sanitary Law. The following

gentlemen have been appointed the first lecturers:—Preventive Medicine—Dr. B. W. Richardson, F.R.S.; Practical Sanitary Science: (a) Medical and Chemical—Prof. Corfield; (b) Engineering and Construction—Capt. Douglas Galton, R.E., C.B., F.R.S. Jurisprudence and Sanitary Law—Mr. W. H. Michael, Q.C., F.C.S. It is proposed that each session should occupy about twelve lectures, and the course will embrace the subjects included in the examinations of the Sanitary Institute of Great Britain and other examining bodies. The school will be open to all classes and to persons of either sex.

THE Social Science Congress was opened at Manchester yesterday, under the presidency of the Bishop of Manchester.

WE record with sincere regret the death of Mr. Henry Negretti, the well-known optician, and inventor of the deep-sea thermometer to which his name is attached. Mr. Negretti died on Wednesday last week at the age of sixty-two years. What his inventive genius did for the work of scientific research many of our readers know. His death is a real loss to science, as it will be to many who had substantial cause to know the depth of his generosity.

MR. R. J. USSHER, the explorer of the Pleistocene caves near Cappagh, Co. Waterford, has added to his discoveries a "sub-marine crannog." This is a new feature in reference to the Irish lake dwellings; for although some of them were known to be of very ancient date yet no trace of them had been recorded from the submerged bogs.

THE commemoration of the eighteenth centenary of the destruction of Pompeii—rather a strange event on which to hinge a celebration of any kind—appears to have been a great success. It attracted a large concourse of visitors, for whose delectation several excavations were made, and innumerable objects of great interest brought to light. One house excavated seems to have been a bird-seller's shop, judging from the small bones found, the little drinking vessels, and the quantities of millet and hemp seed, and what looked like small beans. The memorable feature of the commemoration, however, is the volume issued by the Directorate of the Museums of Naples. The eminent astronomer, Prof. Palmieri, contributes a paper on Vesuvius in the times of Strabo and Spartacus, and on the changes it underwent A.D. 79. The Chevalier Ruggiero discourses effectively on the eruption itself, and Signor Scacchi describes the houses demolished by lightning. The other fifteen contributions which complete the volume treat of every aspect of the public and private life of Pompeii.

THE second part of the magnificent "Herefordshire Pomona," brought out by the Woolhope Club, has been issued. We are pleased to hear that the work has been so successful that the club have resolved to increase the size of the parts, so as to complete the work as soon as possible. To the present part Dr. Bull contributes a curious and interesting paper on "Modern Apple Lore," as also "A Sketch of the Life of Lord Scudamore," with a very fine large portrait; and Sir H. E. C. Scudamore Stanhope a paper "On the Cordon System of Growing Pears." The part contains many plates of exquisitely coloured illustrations of varieties of apples and pears.

THE Engineering Laboratory, in connection with the Technical Department of University College, was opened to students yesterday. A private view to representatives of the press was given on Tuesday afternoon. The faculties of Arts and Laws and of Science were opened yesterday by an Introductory address by Prof. Charles Graham on Technical Education.

IN a paper on Experimental Determination of the Velocity of Light, read at the Saratoga meeting of the American Association by Mr. A. A. Michelsen, of the U.S. Navy, the author concludes as the result of an elaborate series of experiments, that the velocity of light *in vacuo* is 299,828 kilometres per second. See NATURE, vol. xviii. p. 195.

GENERAL MYER, the chief officer of the U.S. Signal Office, has issued the first number of a French edition of the meteorological observations taken at the several meteorological stations placed under his supervision.

M. ANGOT, Professor of Physics to the Lycée Fontanes, has been appointed meteorologist to the Central Bureau of Paris.

THE French Northern Railway Company posts up daily at its principal stations the warnings and weather maps, issued by the Central Bureau of Paris. The meteorological news of the principal sea-ports on the railway system of the Company are also noted.

A METEOROLOGICAL station, as we announced in our last impression, will be established at Mont de Mignons, in the vicinity of Nice. It should be added that an agronomical station will be placed in the same locality. The total expense is estimated at 40,000*l*.

THE special Museum of Algerian industrial and natural products, established in the Palais de l'Industrie twenty years ago, has been broken up. A part of it has been sent to the Museum of the French Colonies at the Ministry of Marine and Colonies, and the other to the Ethnographical Museum, which is being fitted up at the Trocadero.

IN a small pamphlet entitled "Notes from the History of my Parrot in Reference to the Nature of Language" (a reprint from the *Journal of Mental Science*) Dr. Samuel Wilks aims at proving that language, in its larger sense, has its rudimentary framework in the inferior creatures. The result of his observations as to the parrot's faculty of acquiring language are "that it has a vocal apparatus of a most perfect kind, that it can gather through its ear the most delicate intonations of the human voice, that it can imitate these perfectly by continued labour, and finally, hold them in its memory; also that it associates these words with certain persons who have uttered them; also that it can invent sounds corresponding to those which have emanated from certain objects."

THE terrific hurricane which passed over Brisbane and the suburbs on the night of June 23, unfortunately did some very serious damage in the Botanic Gardens and in the Acclimatisation Society's grounds. Numbers of large trees were torn up by the roots, and branches were scattered in all directions. At Bower Park numerous valuable trees and plants were injured, and it will take much time and labour to repair all the mischief.

THE *City Press* states that it is intended shortly to present the honorary freedom of the Leathersellers' Company to Prof. Owen.

BY the last mail from China we learn that there has been a severe earthquake in Western China, which is said to have caused serious damage in the provinces of Szechuen, Shensi, and Kansu. From Manila the intelligence also comes that Surigao has experienced several disastrous earthquakes which commenced on July 1. The shocks are described as even stronger than that felt there in 1875. Between July 1 and 13, beyond which latter date we have no news, no less than seventy shocks had been felt. The damage to houses had been considerable, but no lives had been lost.

MR. E. KNIPPING, of Yedo, has just published a *brochure* on the typhoons which occurred about a year ago in the China and Japan seas. Mr. Knipping has embodied in it the results of his own personal experience and information, derived from the loss of ships which were caught in the gales.

THE *Transactions* of the Norfolk and Norwich Society for 1878–9 contain, as usual, several papers of value. Mr. J. H. Gurney describes a visit he paid to "the Gannet City," as he calls the Bass Rock in the Firth of Forth. "Norfolk Decoys" is an interesting paper by Mr. T. Southwell, and Mr. John Cordeaux contributes "Some Recent Notes on the Avi-Fauna

of Lincolnshire," and Mr. H. B. Woodward a memoir of Samuel Woodward. Ornithological and Meteorological Notes for 1878, and Part 9 of the Fauna and Flora of Norfolk (Hymenoptera—Chrysididæ and Aculeata) by Mr. J. P. Bridgman fill up the volume.

WE learn from the annual report of the Central Meteorological Observatory at St. Petersburg, just appeared in the *Repertorium für Meteorologie* for the years 1877 and 1878, that the Observatory received accurate meteorological observations from 133 Russian stations.

"ACCIDENTS in the Comstock Mines and their Relation to Deep Mining" forms the subject of a recent paper to the American Institute of Mining Engineers, by Mr. Church, M.E. He points out that heat, the peculiar mode of timbering in square sets, the almost exclusive use of nitro-glycerine powders, the necesssity of frequent repairs to shaft timbers, the incessant movement of the rocks through which the shafts are sunk, making accidents in hoisting more than ordinarily frequent, and the necessity of transporting large quantities of rock through narrow gangways entirely by human labour, are the conditions in which mining in the Comstock may be said to suffer rather more than the usual liability to danger. Two of the causes, both connected with the movement of the ground, may be expected to increase with depth. Together with the heat they comprise 40 per cent. of the whole number of accidents. It is concluded that the conditions of deep mining will increase 40 per cent. of the causes which lead to casualties, leaving 60 per cent. unaffected.

THE silicates which form crystalline rocks (the formation of which is supposed to have occurred at a high temperature) allow of being fused in the laboratory, and the products of this fusion are of great geological interest. Not a few are chemically altered in the process, because they contain hydrogen or fluorine, or both. In a recent paper to the Berlin Academy Prof. Rammelsberg has discussed the behaviour of the two fluorine-containing silicates, topaz and mica, at a high temperature. It appears that out of both the fluorine is wholly or partly volatilised, escaping partly in the free state, partly in the form of fluorides. The two minerals, however, behave differently in that, whereas in the glowing mica the proportion of the electro-positive elements is not altered, in the glowing topaz a large quantity of silicium and a smaller of aluminium is wanting.

THE number of journals and reviews published in the twenty-two cantons of Switzerland is 519, of which 249 are political journals, 30 literary, 39 religious, &c. It is in the canton of Berne that most journals are published, viz., 71; then comes the canton of Zurich with 68; the cantons of Glarus and Uri have only 3 journals each.

A FRENCH populariser of science, Prof. Laurendeau, of Bordeaux, endeavours to give an idea of universal gravitation by using a terrestrial globe to which small figures are attached by means of pieces of caoutchouc. On pulling a figure from the globe, then letting go, it falls back wherever its position on the globe. Two such figures being attached on opposite sides of the globe, demonstrate that what we call high or low is merely greater or less distance from the centre of the globe. To illustrate the case of Saturn with its ring, Prof. Laurendeau uses a sphere rotated about a horizontal axis; in the equator of this sphere are arranged metallic sectors attached to the centre by threads of caoutchouc. On rotation commencing, the sectors come out, and by virtue of persistence of impressions on the retina, one sees Saturn's ring. Again, two balls of the same mass and volume are attached to suspended threads; the threads are twisted round each other, then left to untwist, whereupon the balls separate by centrifugal force, gravitating round a common centre between them. Then these balls are replaced by a large ball and a small one; and this time the small gravitates round the large. Once more a solid lead ball and a large inflated balloon, being similarly treated, the larger gravitates round the smaller, &c.

DR. J. PELLETAN in an article on Microscopes in *La Nature*, states that English microscopes are much superior to those made in France; the former comply with all the desiderata, while the latter are far behind. But the English are at least twice the price of the French. Nearly all cheap English microscopes, Dr. Pelletan states, are bad.

WE have received the programme of the course of lectures during the coming winter in connection with the Bristol Museum and Library, in which scientific subjects bear a prominent part. During the Christmas holidays Prof. S. P. Thompson will give three lectures on Frost, Ice, and Snow, and Mr. W. J. Sollas on Glaciers, Ice Action in the Arctic Regions, and Ice Action in the Past.

"EDISON'S FAST SYSTEM OF TELEGRAPHY" is the subject of a descriptive paper in the October *Scribner* and the occasion of the publication of a new portrait of the inventor by Francis Lathrop. This system is the little known Automatic Telegraph which for a year was in operation between New York and Washington, and attained the marvellous speed of several thousand words per minute, but has now disappeared in the litigation of rival companies. *Scribner* has now had papers on the three discoveries of Mr. Edison, which are regarded by him as the most important, viz.: the Electro Motograph principle (involved in Phonograph, Telephone, &c.), the Carbon Button and the Automatic Telegraph.

IN the Paris International Exhibition of Sciences applied to Industry luminous dials for clocks are now sold, on which the hour can be read during the whole of the night without the help of any light whatever. Although fading gradually the phosphorescence is sufficient to serve till daylight. Barometers and thermometers are said to be prepared on this principle for night balloon ascents when no moon is visible. These substances are prepared according to the principle defined by M. Edmond Becquerel in his work on Phosphorescence.

M. H. LESOUDIER, of Paris, will shortly publish a large work on the natural history of birds, entitled "Les Oiseaux dans la Nature; Description pittoresque des Oiseaux utiles." The authors are MM. Rambert and Robert. The work will contain no less than sixty chromo-lithographs, and will besides be profusely illustrated with woodcuts.

THE Nagasaki *Rising Sun* states that the prospects of another new coal mine on an extensive scale being shortly opened in the Island of Nakanoshima are looked upon as very promising. Preliminary operations were commenced some time ago, and it is understood that they are now nearly completed. The Island of Nakanoshima is situated about twelve miles from Nagasaki, and contains some fine seams of coal.

IN his just published report on the trade and commerce of Taganrog, Her Majesty's Consul tells us that a scourge in the shape of a destructive insect—the *Amsoplia austriaca* beetle—has revisited that region. It appeared in the steppe, sixty miles to the north of Taganrog, as well as at Mariapol, in immense swarms, and committed great devastation among the corn crops. These insects attack the new corn, and have destroyed many million roubles' worth of produce. They deposit their eggs at a depth of from three to four inches in the ground, preferring rich dark soil where wheat is grown to any other, and it is stated that the lapse of one, or even two years is necessary to complete the metamorphosis. It is asserted that, after the larva has quickened, the offspring buries itself deeper in the ground until it arrives at maturity.

The following works of scientific interest will be published by Messrs. Macmillan and Co., during the coming season:—"A Treatise on Comparative Embryology," by Mr. F. M. Balfour, F.R.S.; the second part of the second volume of Professors Roscoe and Schorlemmer's "Treatise on Chemistry"; this, which is just ready, completes the "Inorganic Chemistry;" Prof. Boyd Dawkins' "Early Man in Britain"; Prof. Gamgee's "Text-Book of the Physiological Chemistry of the Animal Body;" "Pharmacology and Therapeutics" and "Natural History in the Bible," by Dr. Lauder Brunton, F.R.S.; "A Manual of Geology," by Prof. Geikie, F.R.S.; "Structural Botany on the Basis of Morphology," by Prof. Asa Gray; "Blowpipe Analysis," from the German of J. Landauer, by Messrs. James Taylor and W. E. Kay; "Questions on Chemistry," by Mr. Francis Jones; "Easy Lessons on Heat," by Miss C. A. Martineau; "Easy Lessons on Light," by Mrs. F. E. Awdry; "A Handbook of Double Stars," with a Catalogue of 1,200 Double Stars and Extensive Lists of Measures for the Use of Amateurs, by Edward Crossley, F.R.A.S., Joseph Gledhill, F.R.A.S., and James M. Wilson, F.R.A.S., with Illustrations; and a new and thoroughly revised edition of "Pharmacographia," by Messrs. Flückiger and Hanbury. Prof. Huxley's "Introductory" to the Science Primers, has already been announced.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) rom South Africa, presented by Mr. E. Meyerstein; a Black Rat (*Mus rattus*) from Rangoon, presented by Mr. R. M. Middleton; a Norwegian Lemming (*Myodes lemmus*) from Norway, presented by Mr. James Shuter, F.R.C.S.; a Bonelli's Eagle (*Nisaetus fasciatus*) from Mogador, presented by Capt. W. P. Forwood; a King Parrakeet (*Aprosmictus scapulatus*) from New South Wales, presented by General Blake; a White-backed Piping Crow (*Gymnorhina leuconota*) from South Australia, presented by Mrs. Buchanan; a Silky Marmoset (*Midas rosalia*) from Brazil, a Malbrouck Monkey (*Cercopithecus cynosurus*) from West Africa, deposited; a Red-billed Tree Duck (*Dendrocygna autumnalis*) from South America, purchased; a Brown Bear (*Ursus arctos*) from Russia, received in exchange.

MOUNT ETNA

SHORTLY after the eruption of Mount Etna in May and June last M. H. de Saussure visited the mountain, and made a minute exploration of the region about the sources of the eruption. The results of this examination he describes in a series of letters in the *Journal de Genève* from June 17 to July 4, copies of which M. de Saussure has sent us, along with a note containing additional observations. On his first ascent he and his guide had to spend the night on Monte Temperossa in rather critical circumstances and with the scantiest supply of food and drink. Indeed, it seems to have taken a day or two after reaching a supply of water below ere M. de Saussure's thirst could be quenched. He had observed large patches of a deep black attached to the rocks, and had been puzzled to know what they were. His thirst, however, quickened his perception, and on scratching away about a centimetre of ashes he found underneath what he had half expected, beautiful white snow. The failure of this first excursion determined M. de Saussure to choose another point of departure than Lingugrossa, and to devote three days if necessary to traverse the neighbourhood of the cone. He thus succeeded in reaching the upper limits of the eruption on the north side. The crevasse which has been opened on Etna has divided the volcano into two parts. On the north face it extends to the valley which bounds the mountain; on the south face it seems to be arrested half way. Some of the details of the eruption have already been given in NATURE, vol. xx. p. 198. On the north face the large crevasse gave out two considerable streams, superposed in the same fault. The upper stream began in the neighbourhood of the cone of Etna, and was arrested to the east of Monte Pernicro. Thence the crevasse is quite exposed, and gave out only eruption of gas. Below Monte Pizzello there is formed a cone of ashes which gave out no lava. From this point the crevasses continue exposed to the ravine which separates Monte Nero from Monte Temperossa. Here are the sources and centres of the great lava stream which extend to near Mojo. M. de Saussure describes in detail the upper stream, which appears not to have been previously visited.

This eruption first appears at a height of about 2,700 metres, at the foot of the slopes of the upper plateau which supports the principal cone (Monte Morigibello). A violent explosion has here opened the side of the mountain, throwing out a mass of rocks, and forming a steep gulf in which the northern crevasse seems to terminate. Below this point of explosion the lava was thrown out in great abundance, and formed a current at first narrow, which afterwards inundated the slopes of a high plateau spreading over a distance of several kilometres. At the point of departure was formed a sugar-loaf cone of small height, which, on June 13, was still very active, and whence escaped with a hissing sound a thick smoke of vapours, mixed occasionally with great flames resulting from the combustion of gas. The lava was spread over a vast inclined plateau, flowing over very rough streams of recent lava, on which it is broken up to an infinite extent as far as the foot of a mountain with three craters (Monte Pernicio) which turns it to the east.

An important fact observed by M. de Saussure is that these lavas flowed over the snow, and that at the time of his visit even they rested on a thick bed of that substance. In fact, in all the faults of the lava, in all the openings, at the bottom of all the ravines resulting from the sinking of the lavas, snow was found, often several metres in thickness. Nothing proves better, M. de Saussure thinks, how bad a conductor of heat the eruptive matter is. The terminal end, as it rolls down, carpets the ground with blocks resulting from the continual rupture of the already solidified envelope, and thus forms a base on which afterwards flows the viscous current. At the same time a large mass of snow must have been melted. M. de Saussure saw traces of a large number of streams loaded with ashes which had been precipitated from all the rocks and washed the slopes of the snows, which extend much lower than the lava stream. One result of this eruption over snow is that the lava is mixed with a mass of mud, the melting snow diluting the dust resulting from the porphyrisation of the blocks at the same time as the shower of ashes from the great crater falls on the surface of the current. The fire and water ceaselessly intermingling by the mechanical action of the burning gravel, produced a sort of muddy marmalade, which, rapidly fusing by the persistent heat of the lavas, gave rise to clouds of vapour and left all the stream, all its blocks, all its pebbles, covered with a layer of dry mud, which turns into dust and gives to the new lavas a grey colour which prevents them from being distinguished at a distance from old lavas.

Below the upper lavas the slopes which extend in the direction of Monte Nero are covered with vast fields of hard and deep snow. Their surface is all strewn with yellow spots, so that at a distance they seem covered with sulphur. This appearance is due to the abundant efflorescence of ferrous chloride which condenses on the surface of the snow, and which has formed small mound-like masses, mixed to a small extent with agglutinated ashes. The whole of the snow is, moreover, covered with patches of hardened mud of the size of a plate, and even much larger, also ornamented with yellow efflorescence, and mostly cracked like dried mud or split from bottom to top by a push which has raised them and broken them into a star-like shape. M. de Saussure thinks that these singular accidents are due to deep emanations, and seem to show that under the snow the ground is riddled with crevasses in direct communication with the volcanic centre. The acid vapours reaching the lower surface of the snow are there condensed by the cold; but gradually they reach the surface, and have then formed an infinite number of small sources, which are charged with mud because the ashes of the old subjacent lavas have been diluted with water resulting from the condensation of vaponr against the under surface of the snow, increased by the snow melted by the heat of these same vapours. After quitting the snows, an immense area of sand-hills is met with covered with blocks from the crater of Etna.

M. de Saussure paid a visit to the great cone of Etna in company with an English and an American tourist. As they were walking over the lower slopes of the cone of ashes, he observed a small crack in the fine sand which covered the ground. This soon ceased to be visible, and suddenly M. de Saussure saw a much larger crevasse open under his feet, and he felt at the same time the ground begin to glide down the steep slope. He fled

as fast as he could, and reached a solid standing-ground, but not before perceiving that the guide, who walked behind him, had sunk up to the middle in the sand, and indeed soon disappeared. All the slope sank with increasing swiftness, swelling out at the bottom and opening out to give forth a stream of mud of at least ten metres in height, which shot like a wild torrent across the plateau, and precipitated itself towards the Val de Bove. Immediately all the moving sand, to more than thirty metres in height, was diluted and drawn along, as were also the stones and blocks it contained, and which rolled over each other pell-mell. Fortunately they succeeded in extricating the guide, covered with mud, torn and bruised.

Seeking the origin of these eruptions of mud, M. de Saussure observes first that they take place in the neighbourhood of the central cone of Etna, and that they all escape from the foot of the cone and the very inclined slopes which support it. They proceed then exclusively from the water stored in the beds of ashes. These causes seem to account for this mass of water. 1. The hot vapours. The cone seems almost exclusively composed of ashes and movable stones, and during the eruption an enormous mass of vapour must have traversed it. There are, moreover, numerous fumeroles in the upper part. These vapours have been condensed, all the more readily that they have encrusted the mantle of snow which envelops the summit of the mountain. 2. The melting of this snow, determined less by the fall of ashes on the surface than by the heat which radiates from the interior and the vapours which traverse the porous mass of the cone. 3. The abundant vapours falling from the cloud of vapours projected by the crater. The two first causes are the most important; the last has most especially given rise to surface streams, the traces of which are apparent. The water gradually collecting in excess in the lower parts of the cone, ends by forming these enormous deposits, which, at a given moment, yielding to their weight, cause an eruption to the outside, turning over and diluting the beds of ashes which oppose its exit.

In a communication to us M. de Saussure gives an analysis of the little mud-heaps which have projected through the snow. They are composed of a grey powder formed of pozzolana (spongy amorphous silicates), white, grey, and black (augite), mixed with (*b*) amorphous sulphur (yellow and orange coloured); (*c*) calcium sulphate (hydrated) in numerous well-defined small crystals; (*d*) sodium and potassium sulphate; (*e*) calcium and potassium chloride; (*f*) perchloride of iron and oxychloride of iron; (*g*) indication of copper salts.

The crystals are all of alabaster, and so wet that they can only have been formed after the eruption of the mud in drying. There is no crystallised silica nor feldspar. The sulphur in the mud is curious to observe. It must have condensed out of the eruptive vapours which formed the water to make the mud by mixing with old ashes under the snow, and by their expansion driven small quantities of that mud through the snow. This mud, when heated, evaporates sulphur, sulphurous and sulphuric acid, some perchloride of iron, and some hydrochloric acid.

THE ACTION OF HEAT IN VACUO ON METALS[1]

IN the course of my experiments on electric lighting I have developed some striking phenomena arising from the heating of metals by flames and by the electric current, especially wires of platinum, and platinum alloyed with iridium. These experiments are in progress.

The first fact observed was that platinum lost weight when heated in a flame of hydrogen, that the metal coloured the flame green, and that these two results continued until the whole of the platinum in contact with the flame had disappeared. A platinum wire four-thousandths of an inch in diameter, and weighing 306 mgrms., was bunched together and suspended in a hydrogen flame. It lost weight at the rate of a fraction less than 1 mgrm. per hour as long as it was suspended in the flame. When a platinum wire is stretched between two clamping posts, and arranged to pass through a hydrogen flame, it is coloured a light green; but when the temperature of the wire is raised above that of the flame, by passing a current through it, the flame is coloured a deep green. To ascertain the diminution in the weight of a platinum wire when heated by the electric current, I placed between two clamping posts a wire five-thousandths of an inch in diameter, and weighing 266 mgrms. This wire, after it was brought to incandescence for twenty minutes by the current, lost 1 mgrm. The same wire was then raised to incandescence; for twenty minutes it gave a loss of 3 mgrms. Afterwards it was kept incandescent for one hour and ten minutes, at which time it weighed 258 mgrms.—a total loss of 8 mgrms. Another wire, weighing 343 mgrms., was kept moderately incandescent for nine consecutive hours, after which it weighed 301 mgrms., showing a total loss of 42 mgrms. A platinum wire twenty-thousandths of an inch in diameter was wound in the form of a spiral one-eighth of an inch in diameter and one-half an inch in length. The two ends of the spiral were secured to clamping posts, and the whole apparatus was covered with a glass shade 2½ inches in diameter and 3 inches high. Upon bringing the spiral to incandescence for twenty minutes that part of the globe in line with the sides of the spiral became slightly darkened; in five hours the deposit became so thick that the incandescent spiral could not be seen through the deposit. This film, which was most perfect, consisted of platinum, and I have no doubt but that large plates of glass might be coated economically by placing them on each side of a large sheet of platinum, kept incandescent by the electric current. This loss in weight, together with the deposit upon the glass, presented a very serious obstacle to the use of metallic wires for giving light by incandescence, but this was easily surmounted after the cause was ascertained. I coated the wire forming the spiral with the oxide of magnesium, by dusting upon it finely powdered acetate of magnesium: while incandescent the salt was decomposed by the heat, and there remained a strongly adherent coating of the oxide. This spiral so coated was covered with a glass shade, and brought to incandescence for several minutes; but instead of a deposit of platinum upon the glass, there was a deposit of the oxide of magnesia. From this and other experiments I became convinced that this effect was due to the washing action of the air upon the spiral; that the loss of weight in and the coloration of the hydrogen flame were also due to the wearing away of the surface of the platina to the attrition produced by the impact of the stream of gases upon the highly incandescent surface, and not to volatilisation, as commonly understood; and I venture to say, although I have not tried the experiment, that metallic sodium cannot be volatilised in high vacua by the heat derived from incandescent platinum; any effect that may be produced will be due to the washing action of the residual air. After the experiment last described I placed a spiral of platinum in the receiver of a common air-pump, and arranged it in such a manner that the current could pass through it, while the receiver was exhausted. At a pressure of 2 millimetres the spiral was kept at incandescence for two hours before the deposit was sufficient to become visible. In another experiment, at a higher exhaustion, it required five hours before a deposit became visible. In a sealed glass bulb, exhausted by a Sprengel pump to a point where a quarter of an inch spark from an induction-coil would not pass between points 1 millimetre apart, was placed a spiral, the connecting wires passing through the glass. This spiral has been kept at the most dazzling incandescence for hours without the slightest deposit becoming visible.

I will now describe other and far more important phenomena observed in my experiments. If a short length of platinum wire one-thousandth of an inch in diameter be held in the flame of a Bunsen burner, at some part it will fuse, and a piece of the wire will be bent at an angle by the action of the globule of melted platinum; in some cases there are several globules formed simultaneously, and the wire assumes a zigzag shape. With a wire four-thousandths of an inch in diameter this effect does not take place, as the temperature cannot be raised to equal that of the smaller wire, owing to the increased radiating surface and mass. After heating if the wire be examined under a microscope, that part of the surface which has been incandescent will be found covered with innumerable cracks. If the wire be placed between clamping posts, and heated to incandescence for twenty minutes, by the passage of an electric current, the cracks will be so enlarged as to be seen with the naked eye; the wire, under the microscope, presents a shrunken appearance, and is full of deep cracks. If the current is continued for several hours these effects will so increase that the wire will fall to pieces. This disintegration has been noticed in platina long subjected to the action of a flame by Prof. John W. Draper. The failure of the process of lighting invented by the French chemist Tessie du Motay, who raised sheets of platinum to incandescence by

[1] A Paper read by Mr. T. A. Edison before the American Association for the Advancement of Science; Saratoga Meeting.

introducing them into a hydrogen flame, was due to the rapid disintegration of the metal. I have ascertained the cause of this phenomenon, and have succeeded in eliminating that which produces it, and in doing so have produced a metal in a state hitherto unknown, and which is absolutely stable at a temperature where nearly all substances melt or are consumed; a metal which, although originally soft and pliable, becomes as homogeneous as glass and as rigid as steel. When wound in the form of a spiral it is as springy and elastic when at the most dazzling incandescence as when cold, and cannot be annealed by any process now commonly known, for the cause of this shrinking and cracking of the wire is due entirely to the expansion of the air in the mechanical and physical pores of the platinum, and the contraction upon the escape of the air. Platinum as sold in commerce may be compared to sandstone, in which the whole is made of a great number of particles with many air spaces. The sandstone upon melting becomes homogeneous and no air spaces exist.

With platinum or any metal the air spaces may be eliminated and the metal made homogeneous by a very simple process. This process I will now describe. I had made a large number of platinum spirals, all of the same size and from the same quality of wire; each spiral presented to the air a radiating surface of three-sixteenths of an inch; five of these were brought by the electric current up to the melting-point, the light was measured by a photometer, and the average light was equal to four standard candles for each spiral just at the melting-point. One of the same kind of spirals was placed in the receiver of an air-pump, and the air exhausted to 2 millimetres; a weak current was then passed through the wire, to slightly warm it for the purpose of assisting the passage of the air from the pores of the metal into the vacuum. The temperature of the wire was gradually augmented, at intervals of ten minutes, until it became red. The object of slowly increasing the temperature was to allow the air to pass out gradually and not explosively. Afterward the current was increased at intervals of fifteen minutes. Before each increase in the current the wire was allowed to cool, and the contraction and expansion at these high temperatures caused the wire to weld together at the points previously containing air. In one hour and forty minutes this spiral had reached such a temperature without melting that it was giving a light of twenty-five standard candles, whereas it would undoubtedly have melted before it gave a light of five candles had it not been put through the above process. Several more spirals were afterwards tried, with the same result. One spiral, which had been brought to these high temperatures more slowly, gave a light equal to thirty standard candles. In the open air this spiral gave nearly the same light, although it required more current to keep it at the same temperature. Upon examination of these spirals, which had passed through the vacuum process, by the aid of a microscope no cracks were visible; the wire had become as white as silver, and had a polish which could not be given it by any other means. The wire had a less diameter than before treatment, and it was exceedingly difficult to melt in the oxy-hydrogen flame. As compared with untreated platinum, it was found that it was as hard as the steel wire used in pianos, and that it could not be annealed at any temperature.

My experiments with many metals treated by this process have proved to my satisfaction, and I have no hesitation in stating that what is known as annealing of metals to make them soft and pliable is nothing more than the cracking of the metal. In every case where a hard drawn wire had been annealed a powerful microscope revealed myriads of cracks in the metal. Since the experiments of which I have just spoken I have, by the aid of Sprengel mercury pumps, produced higher exhaustion, and have, by consuming five hours in excluding the air from the wire and intermitting the current a great number of times, succeeded in obtaining a light of eight standard candles from a spiral of wire with a total radiating surface of 1-32nd of an inch, or a surface about equal to one grain of buckwheat. With spirals of this small size which have not passed through the process, the average amount of light given out before melting is less than one standard candle. Thus I am enabled, by the increased capacity of platinum, to withstand high temperatures, to employ small radiating surfaces, and and thus reduce the energy required for candle light. I can now obtain eight separate jets, each giving out an absolutely steady light, and each equal to sixteen standard candles, or a total of 128 candles, by the expenditure of 30,000 foot-pounds of energy, or less than one horse-power. As a matter of curiosity I have made spirals of other metals, and excluded the air from them in the manner stated. Common iron wire may be made to give a light greater than platinum not heated. The iron becomes as hard as steel, and just as elastic. Nickel is far more refractory than iron. Steel wire used in pianos becomes decarbonised, but remains hard, and becomes the colour of silver. Aluminium melts only at a white-heat.

In conclusion, it may be interesting to state that the melting-points of many oxides is dependent on the manner of applying the heat; for instance, pure oxide of zirconium does not fuse in the flame of the oxy-hydrogen blow-pipe, while it melts like wax and conducts electricity when on an incandescent platinum spiral which is at a far lower temperature; on the other hand oxide of aluminum easily melts in the oxy-hydrogen flame, while it only vitrifies on the platinum spiral.

THE INAUGURATION OF ARAGO'S STATUE

THE statue to Arago recently unveiled at Perpignan is not the first erected to that great astronomer and greater physicist. In 1867 M. Isaac Pereire, then representative of the native place of Arago in the Imperial Chamber of Deputies, erected one at his own expense at Estagel. The inauguration was accompanied by speeches delivered by the generous donor, M. Bertrand, the perpetual secretary of the Academy of Science, and others. It was stated then that Arago had supported against his own party the construction of the railways by public companies, and had been grossly abused by some of his political friends. Although a political leader, it must be said, to the glory of Arago, that he never was influenced by party considerations. He was always writing, and speaking, and voting according to the *dictamina* of his own judgment. These facts should be remembered, as efforts have been made in the recent Arago celebration, to degrade him into a mere politician, which never was the case. Arago was made a member of the Provisional Government of France in February, 1848; it was owing to his personal exertion that the abolition decree was proclaimed before the convocation of the National Assembly. It is true that he was appointed in the beginning of May one of the *quinquemvirs* of the Executive Commission. But this Government was overthrown by the popular rising of the end of June, and from that time he abstained from taking any prominent part in politics.

Arago was not rich, his works having been mostly published in the *Annuaire du Bureau des Longitudes* without any copyright, and sold for the benefit of the Bureau, of which he was the most influential member. His paying works were all of them posthumous, and edited by M. Barras, the Perpetual Secretary of the Agricultural Society of France. The sale was not so large as anticipated, and the publisher who purchased the copyright from the inheritors failed. The sale of the *Annuaire* was so large during Arago's lifetime, that the Bureau had a profit by it. Since his death it has become necessary to provide special funds for the publication of that useful work.

Arago had no salary at all as director of the Observatory. He was appointed every year by the Bureau, receiving only 200*l.* for his membership. His other salaries were 50*l.* as a member of the Academy of Sciences, 250*l.* as Perpetual Secretary, and when he was lecturing on astronomy 50*l.* The functions of deputy and member of Municipal Council of Paris being entirely gratuitous, he was no receiver of any other public moneys. Under the Republic his membership of the Assembly brought him 1*l.* a day.

From the eloquent *éloge* pronounced by M. Paul Bert at the recent inauguration, we take the following extract:—

"To contemplate Arago under all the aspects that may attract the admiration of posterity we must think of him as a man of science overturning the Newtonian hypothesis of the emission of light, determining the physical constitution of the sun, explaining the scintillation of the stars, the nature of the aurora borealis, discovering magnetisation by currents, the origin of the electric telegraph, extending to all bodies magnetic properties; finally, for I must limit myself to the most prominent points, indicating to the most eminent of his disciples the star still unknown and invisible, whose discovery introduced order among the perturbed planets, and which still remains the most extraordinary mark of the power of human genius. As a professor, again, before three thousand auditors at the Observatory, or in his chair as Perpetual Secretary writing his incomparable scientific notices, or dictating, when blind, his popular astronomy, always, by speech or by pen, marvellous for his clearness, his

accuracy, his power and fulness, elevating all he touched, returning to the astonished inventor his discovery developed and fertilised, sowing broadcast his ideas, and rejoicing when others, friends or foes, were enriched by the precious fruits of his genius. As a scientific historian he excelled Condercet, equalled Cuvier and Fontenelle, and was characterised above all others by his eagerness to give every one his due, and his jealous love of justice. As an orator he carried into the tribune the vigour and clearness of the scientific chair, vivified by the emotions of master-spirits, and dominating the assembly by his lofty stature, with his beautiful Southern head, and his eye full of fire. He was a man, in fact, in whom the will to act was united with the consciousness of power, an intelligence marvellously comprehensive and powerfully creative, so bold and yet so prudent at times that it never commited an error that required to be retracted. Of an ardent but loyal nature, ready for power, but incapable of hatred, and thirsting for justice, a heart sensitive and valiant, sometimes drawn, says a contemporary, to show itself severe to the strong in order to support the weak; a soul austere but a brow serene; a father and citizen worthy of the ancient legends, and able, like Carnot on quitting life to bear the noble witness: —'My hands are clean and my heart pure.' From the extent of the sketch you may judge what will be the nature of the picture."

PALÆOZOIC ROCKS IN SOUTH-EAST OF ENGLAND[1]

IN a communication to the Geological Section of the meeting of the British Association at Plymouth in 1878, I called attention to the significance of the result of the deep boring at Messrs. Meux's; as to the upper Devonian beds there met with next beneath the cretaceous strata; also as to the importance of some further knowledge as to the direction of the dip of the said upper Devonian beds. An accurate acquaintance with this point is essentially needed with reference to its immediate bearing on a question which may possibly become one of national importance, namely, the place of the true coal measure series beneath our south-eastern area, and which must serve as an excuse for another short communication on the same subject.

The question involved has attracted the attention of sundry foreign geologists during the past year, and upon our own area facts have been ascertained which now enable us to arrive inferentially at what, but a year since, was mere speculation.

M. Dewalque, at a recent meeting of the Belgian Geological Society, remarked first on the absence of Jurassic and Triassic deposits, as along the palæozoic ridge extending from the Ardennes by the north of France, being just what the borings at St. Trond, Laecken, Menin, and Ostende would indicate. Secondly, that inasmuch as the palæozoic formations of Belgium and the north-west of France are extended into England, it is an important point, with reference to the prolongation of the Belgian coal-basin, that London should be known to be situated immediately over a formation, which is itself so close to the coal measures. "The supposition that the dip of these upper Devonian beds is to the south, and that they belong to the extension of our northern basin is that which is the most probable. The coal formation may therefore occur at a short distance south of London, and at a workable depth.

"With a southern dip it may be that these beds (upper Devonian) belong to the extension of our southern basin. In this case coal may occur in the north as well as in the south, and nearer on this side (north) than on the south. Should there be such a coal basin, it might be as useless as ours (Belgium) of the Condros and the Entre Sambre and Meuse." The exact significance of this latter alternative of the Belgian geologist may not, perhaps, be understood by English geologists generally, as it has reference to a feature in the physical structure of Belgium, but the which is very properly referred to by M. Dewalque, now that the palæozoic band of the Continent is known to reach our south-east district. The band of Belgian and North of France coal-measures may be truly represented as trough-shaped, however produced.

M. Dewalque adds: "Starting from the supposition that our (Belgian) old strata are prolonged westward into England, and from the fact that upper Devonian strata occur under London, we are led to admit that the band of Silurian slates of the Ostende boring must pass north of London. These slates must be separated from the upper Devonian by other beds, such as the black slates of the Menin Shaft, which are Silurian. Considering the geographical position of these three places, together with the east and west direction of our older formations, it would not seem that their prolongation into England would carry them sufficiently north of London, so that the Devonian beds there should represent our Condros basin, and not that of Namur. If, then, at that place (London) we are in a prolongation of the Namur basin, the strata at Meux's must dip south; consequently it is most probable that the coal-measures are to be found at a short distance south."

Such were the inferences drawn by M. Dewalque in 1878 from the results of the boring at Messrs. Meux's.

The supposition that the Silurian strata met with at Ostende would in their course westwards run north of London have been proved by the occurrence of beds of Wenlock age at Ware, near Hertford, twenty miles north of London. This discovery has come most opportunely to supply the information which only a year since was needed, as to the dip of the upper Devonian strata at Messrs. Meux's brewery. The succession of the palæozoic strata in this the English side of the channel, even into the far west, is just what it is in Belgium and the north of France, from Brussels and Ostende from north to south. There the successive members of the series mostly rise to the surface and are exposed in all the valley of denudation extending north from the line of the coal measures, as long since laid down by Dumont.

With this guidance, and in spite of the little as yet known with respect to our own underground structure on the south-east, it can be safely put in relation with what obtains on the European continent for an extent of 400 miles; the order in which the successive members of the palæozoic series rise to the surface from beneath one another there, may be taken as our guide on to the order and relation of the upper Devonian at the end of Tottenham Court Road near Oxford Street, and the section at Ware.

The question of the strike and direction of the dip of the beds at Messrs. Meux's is now determined as forming part of the northern band of the trough containing first, the mountain limestone series, and, next above, the true coal measures.

For practical guidance one point alone remains to be considered: from the place of the Upper Devonian strata in the heart of London, what must be allowed for the breadth of the outcrop of mountain limestone series next in sequence? In parts of Belgium the mountain limestone has been estimated at 600 feet thick; it is less than that in an east and west direction. The nearest place to London at which this is exposed is in the north of the Boulonnais denudation; where, with its associated beds, it may be put at 400 feet. The breadth of such a mass at its outcrop, and with an angle of 30° to 35°, such as the Devonian bed at Meux's had, would be nearly doubled, or about 800 feet; in other words the lower members of the coal measure formation may be fairly expected to occur at about that distance south from a corner of Tottenham Court Road and Oxford Street. The upper, or productive coal-measures, still further to the south.

What has been ascertained beyond all doubt as to the line of section underlying a part of our English area from London to Ware, may safely be taken as holding good for a great extent of country on the east as in the west. The ages of more modern overlying formations do not affect this question, as is shown by the borings now in England, but more abundantly in the European continent. In our attempts to trace accurately hidden physical arrangements of the earth's crust, the restrictions to be observed are—the positive data of the ascertained thickness of the several formations and their several positions, and which enable us to replace, without much chance of error, the line of each band and of its angle of dip.

[1] "Further Evidence on the Range of the Palæozoic Rocks beneath the South-East of England," by R. A. C. Godwin-Austen, F.R.S. Paper read at the Sheffield meeting of the British Association.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

UNIVERSITY COLLEGE, BRISTOL, will shortly commence its fourth Session. The calendar, which is before us, states that there were 448 students in the college in the second session; and in the third, 576, of whom 355 were men and 221 women; 172 came in the day-time and 404 in the evening. Good progress is being made by the Engineering Department, which is designed to afford a thorough scientific education for students intending to become mechanical or civil engineers, surveyors, or architects. The course for engineering is such that students can pursue it during the six winter months of each year, and the council of the

college have arranged with the leading civil and manufacturing engineers in the neighbourhood to receive in their offices and workshops during the summer months, students whose position relatively to the firms would be that of articled pupils. Many of the recent developments in the scheme of instruction in the college are designed to meet the wants of the department. There are in addition general courses in Chemistry, Mathematics, Mechanics, Engineering, Experimental Physics, Surveying, Geometrical Drawing, Geology, Botany, Political Economy, Logic, Law, Modern History, English Literature, Greek, Latin, Ancient History and Literature, French and German. There are evening classes at low fees in most of these subjects. The college is also giving, with the co-operation of the Company of Clothworkers, instruction at Stroud in Chemistry and the Textile Industries. The subject of Logic has been added to the curriculum this year, and lectures on it will be given by Prof. Fanshawe, Fellow of New College, Oxford, who has recently been elected to the post of Classical Professor. The opening lecture of the session is to be given by him on Monday, October 6th, on "The Conditions of Intellectual Progress."

A PRIVATE society under the presidency of Dr. Kummer, Federal Director of the Statistical Board, and which already numbers 200 members, is about to open at Bern a permanent exhibition of educational objects. The exhibition comprises a collection of plans of schools, and of objects for teaching which may be considered as models for schools; a collection of publications (text-books, manuals, &c.), a collection of laws and regulations concerning schools, as well as of reports and school statistics published in Switzerland and elsewhere, and a collection representing the modes of teaching introduced in Swiss schools of all degrees, from Kindergarten to lyceums and universities. Numerous objects from the Swiss cantons and foreign countries have already arrived, and the exhibition will be opened for the public on October 15.

WE learn from the annual report of the University at Odessa, just appeared, that the university numbered 325 students and thirty-nine professors.

SCIENTIFIC SERIALS

THE *Verhandlungen der k. k. zoologisch-botanischen Gesellschaft in Wien* (1878, part ii., and 1879, part i.), contain the following papers:—On the shrub-lichens of Lower Austria; a catalogue of all the species observed in this province, by J. Eman Hibsch.—Mycological researches, by Steph. Schulzer von Müggenburg (3rd paper).—On the diptera-genera *Argyra macq.* and *Leucostola lev.*, by Ferdinand Kowarz.—Account of a coleopterological excursion through Carniola, Carinthia, and Styria, undertaken during the summer of 1878, by Ludwig Miller.—On *Thysa pythonissæ formis*, Kempelen, by Otto Hermann.—On *Amphipogon spectrum*, Whlb., and its position in systematic zoology, by Josef Mik.—On a method for drying freshly collected insects, by Brunner von Wattenwyl.—Review of the arachnida collected by Dr. Otto Finsch in Western Siberia, by Dr. L. Koch.—Bibliographica ornithologica, by Victor von Tschusi Schmidhoffen. This forms a complete catalogue of the whole ornithological literature of the Austro-Hungarian Empire.—On a copious appearance of centipedes, by Josef Paszlavszky.—Researches on æolidiadæ, by Dr. Rudolph Bergh (6th paper).—On the systematics of psyllodæ, by Dr. Franz Löw.—New researches on the fungus-flora of Vienna, by Felix von Thümen, and Wilhelm Voss.—Dipterological notes, by Josef Mik. These papers contain a treatise on *Trochobola cæsarea*, O. S., on *Cyrtopogon meyer dürii*, Mik., and on *Hypocharassus gladiator* the latter being a new species of dolichopodidæ from North America.—On the comparative flora of Wisconsin (2nd supplement), by Th. A. Bruhin.—Researches on the ant-fauna of Asia, by Dr. Gustav Mayr.—On the cultivation of bathing sponges, by Dr. Emil von Marenzeller.—On the history of evolution of the prothallium of *Scolopendrium*, by Dr. Günther Beck.—Researches on the literature and distribution of *Hepaticæ* in Bohemia, by Jos. Dedecek.—Coleopterological results of an excursion to Croatia and Slavonia, by Edmund Reitter, Dr. Eppelsheim, and Dr. von Heyden.—Synonymical observations referring to Bolivar's "Catalogus Orthopterorum Europæ," by Dr. Hermann Krauss.—Researches on two *Pemphigus* species, by Dr. Franz Löw.—Classification tables of European Coleoptera, (first paper containing *Cucujidæ*, *Telmatophilidæ*, *Tritomidæ*, *Mycetaeidæ*, *Endomychidæ*, *Lyctidæ*, and *Sphindidæ*.—On the first stages of two turnip flies, (1) the metamorphosis of *Lonchæa chorea* Meigen, (2) the turnip fly *Anthomyia conformis*, Nödlinger.—Zoological account of the expedition to Western Siberia in 1876, undertaken by order of the Bremen Society for North Polar Expeditions, by Dr. Otto Finsch, Dr. A. Brehm and Count Karl von Waldburg-Zeil-Trauchburg. This elaborate paper treats of the mammals, birds, amphibia and fishes of Western Siberia.—On some new American spiders, by Count Eugen Keyserling.—Lichenological excursions in the Tyrol (20th chapter, Prendazzo), by Dr. F. Arnold.—On some new Tyrolese *Sphegidæ*, by Franz Friedrich Kohl.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, September 22.—M. Daubrée in the chair.—The following papers were read:—On evolution in medicine, by M. Sedillot. The sagacious character of the Hippocratic ideas is demonstrated by the evolution of modern medicine.—Influence of atmospheric electricity on the growth, flowering, and fructification of plants, by M. Naudin. M. Grandeau, from experiments with tobacco and maize, affirmed florescence and fructification to be retarded and impoverished by withdrawal of plants from atmospheric electricity (by means of iron or wooden cages placed over them, the proximity of trees, or other bodies attracting atmospheric electricity). M. Naudin, from an extension of such experiments, thinks the influence of atmospheric electricity on plants is complex and far from being understood as yet. It is probably modified first by the nature of the plant species, then by climate, season, temperature, degree of light, dry or wet weather, perhaps, too, by the geological structure or mineralogical composition of the soil, whose layers do not equally conduct electricity. Possibly, too, tree species do not all withdraw the electric influence in the same degree.—Theoretical essay on the law of Dulong and Petit; case of perfect gases, by M. Willotte.—A work by MM. Franchet and Savatier, on the plants of Japan, was presented. It gives nearly 3,000 species, about one-fourth of which have not before been indicated in that country, and more than 200 of which are absolutely new. The work is made available for naturalists of the country by means of a table of Japanese synonyms.—On the organisation and classification of the Orthonectida, by M. Giard.—Meteorological observations at Montsouris Observatory in August (table).

CONTENTS

THURSDAY, OCTOBER 9, 1879

EDUCATION

Education, its Principles and Practice, as Developed by George Combe, Author of "*The Constitution of Man.*" Collated and Edited by William Jolly, H.M. Inspector of Schools. (London: Macmillan and Co., 1879.)

THIS book appears at an opportune moment. Inquiries into the philosophy of education are attracting increased attention among teachers, and the universities are taking measures with a view to bring to light the best rules for school teaching, and the principles which underlie those rules. In these circumstances, the laborious editor of this volume has done a public service, in placing on permanent record and in a modern form, the principal writings of one of the most original thinkers and earnest workers in the department of educational reform. But for such an enterprise, the speculations of Combe, many of which originally appeared in a fugitive form, or in books which are now well-nigh forgotten, would have remained unknown to the present generation; although some at least of his teaching is as much needed now as half a century ago, when it first appeared.

George Combe was born in 1788, and the seventy years of his life coincided with the period in which the national conscience became awakened to the necessity for public instruction; and in which occurred the principal experiments and controversies that have slowly shaped our present national system. His attention was very early directed to the defects, both in the supply of means for education and in the character and quality of such education as was then accessible to the people. A large part of his life was devoted to the exposition and propagation of his views on these subjects. Those views may be thus briefly summarised:—(1) A true science of education should be based on a knowledge of physiology and of mental philosophy. (2) School teaching should be mainly directed to the training of faculties, with special reference to the actual pursuits and duties of life. (3) Hence the study of our own physical constitution, of the phenomena of nature, and of the economic and social laws which govern the happiness of communities, ought to supersede many of the subjects included in the ordinary school routine, much of which he regarded as mere verbiage and as very sterile of intellectual result. (4) While increased attention ought to be given in schools to ethics and religion, in so far as they are deducible from the laws of our own well-being and that of society, the public school ought not to concern itself with dogmatic theology in any form. (5) Special efforts ought to be made to train girls, both to a stronger interest in intellectual pursuits, and to a better understanding of the laws of health and the right way of training young children. (6) A true knowledge of the science of mind for the purposes of education is to be obtained only through phrenology; and the study of this subject is not only indispensable to the teacher and the parent, as the guide to right training; but should also be introduced into the curriculum of the school itself.

These cardinal doctrines were set forth by Combe in his larger works on Phrenology, and on the Constitution of Man; in numerous pamphlets and contributions to periodicals; as well as in lectures delivered in many places, both in England and America. His writings are characterised by clearness, and by considerable wealth and variety of illustration; and by the unadorned and forcible style which comes rather from strong conviction and definite purpose than from conscious literary effort.

To bring together from many books, tracts, and reports of lectures a coherent statement of Combe's teaching was a difficult task. And in one respect his present editor has succeeded. Mr. Jolly is in full sympathy with his author, and has diligently studied his writings. He has acquainted himself with the collateral history of the chief movements in which Combe took part, and has brought down the record both of his achievements and of their results to the latest period. As one of the most energetic and thoughtful of Her Majesty's Inspectors of Schools, and as a careful student both of the history and of the philosophy of the pedagogic art, Mr. Jolly possesses some exceptional qualifications for the task he has undertaken.

Yet, although the book is complete and exhaustive, and is logically arranged, it cannot be said to have been skilfully or artistically edited. Combe's life was spent in a sort of missionary work, in expounding and enforcing to very different audiences, and with varied illustrations, a few principles which he held to be of paramount importance. It was inevitable that he should repeat what was substantially the same thing many times. One might have expected that an editor would select from the voluminous material before him the most effective statement of each of Combe's doctrines, and present them in a concise form likely to attract a modern reader. But Mr. Jolly has preferred to bring together lengthy extracts, and to produce a huge amorphous volume of 800 pages, with manifold reiteration of the same facts and speculations in every variety of form. The book is filled with cross-references, and furnishes quite a curious study of the mode in which a limited number of ideas and facts admit of being stated and restated, combined and recombined, looked at from all sides, and made to occupy the maximum of space. All Mr. Jolly's reminiscences and illustrations seem to revolve round the three or four eminent men, who have more or less adopted Combe's views, and the little group of secular schools—of which it seems that very few now survive—in which those views were most fully carried out. And the repeated reference to the same names becomes after a time not a little wearisome even to the most patient and sympathetic reader.

The book will enable this generation to estimate with tolerable accuracy Combe's true place in the history of education. On the need of scientific instruction, and of training the observant and reasoning powers by the study of natural phenomena, his teaching was much in advance of his own age. His vindication of the importance of some acquaintance with the structure and functions of our own bodies, and with the constitution of man and of society; and especially his demand that the laws affecting wages and capital, and the conditions of industrial success should be taught to children are sound and far-seeing and even now await fuller public recognition. The scant acceptance these doctrines have received from the promoters of public education is largely owing to the use of the word "secular" in connection with Combe and his

favourite schools, and to the unfortunate associations which have happened to cluster round that word. But Combe was an earnestly religious man, and in his view both natural and revealed religion were vital parts of education. He wished, it is true, to exclude controversial theology from the common school; but he strongly advocated the teaching of the Christian faith by clergy and parents at other than school hours. And in the school itself he thought that moral training—the cultivation of benevolence, reverence, and truthfulness—was indispensable. There is no one point on which his theories have been so much misunderstood. He believed that very noble incentives to duty and valuable helps in the formation of character were to be obtained from the wise study of the laws of our own being, and the structure of human society; and his chapter on "Moral and Religious Training through Science"—one of the most original and valuable in the book—is full of wise suggestions and of interesting examples. "The Ten Commandments," he would say, "are as clearly inscribed in the nature and constitution of man as on the tables of stone delivered to Moses." To him the revelations of Divine will and of the nature of human responsibility conveyed to us in science and in the order of nature were as sacred as the teachings of religion, were indeed a substantial part of religion itself. It must be owned that this is a doctrine which has not met with universal acceptance, and the exposition of which in Combe's writings is yet deserving of study. And in like manner his views on the training of children for the duties of citizenship, on a more rational system of teaching for girls, and on the necessity for instructing the teachers of the people in the art and mystery of their profession, were generally right and often profound; and possess hardly less value for this generation than for his own.

Yet it must be admitted that although Combe saw clearly and expounded forcibly some useful truths, he was not distinguished by much breadth of vision; and he certainly did not excogitate a full or philosophical system of education. He believed it possible by pure deduction to evolve a practical scheme from certain scientific principles; and there is evidence throughout the whole of his writings that he attached too little value to the lessons of actual experience, and that a fuller knowledge of child-nature, and of the practical working of schools would have rectified many of the deductions to which he attached most importance. He habitually depreciates the study of language, and repeatedly contrasts what he calls "real" knowledge with linguistic study, to the disparagement of the latter. To him words were mere means of expression and of communication. He never recognised the truth that words are the instruments as well as the representatives of thought; and that the right study of words and their relations is a discipline in logic and one of the most effective means of widening the range of a pupil's intelligence. Nor in his scheme of study was there much room left for history, for poetry, or for literary culture in any form. "*Res, non verba, quæso,*" was his favourite motto; yet it is not too much to say that his conception both of things and of words and of the part they should play in education was inadequate and unsound. And as to his system of phrenology, which he had learned from Spurzheim, and from which he hoped so much as an instrument for the regeneration of society, we must admit that it is now universally discredited by men of science; and that it betrayed Combe into a false method of psychological analysis. He believed that every separate moral propensity or mental gift had its own *habitat* in the brain, and was capable of being separately handled and developed. He thought that it would be enough to show a child that he was deficient, *e.g.*, in the organ of veneration, and then to set him to cultivate that faculty by placing before him appropriate objects for its exercise, and so to restore the balance of his character. Experience however has not confirmed this theory. It may well be doubted whether character has ever been fashioned in this conscious and mechanical way. At all events it does not appear even in this book, that the theory has ever been seriously carried out in practice; or that any one even of Combe's most enthusiastic disciples has accepted it as a working hypothesis, or applied it with success in the government, either of a school or of a home. There can be little doubt that Combe's faith in what he called phrenological science and his constant use of its terminology, vitiated many of his speculations about teaching, and prevented him from arriving at a full or satisfactory solution of the problem he desired to solve.

Few persons are better qualified than the editor of this volume to aid the public in discriminating what is ephemeral and obsolete in Combe's teaching from that which is likely to possess permanent value. This task, however, Mr. Jolly has not achieved and has scarcely attempted. And even those who most appreciate the importance of Combe's contributions to educational science will be fain to own that the bulk of this book is seriously disproportioned to the worth of its contents; and that a more valuable boon to the teacher's profession, and a far worthier and more enduring memorial of Combe himself might easily have been comprised in a volume of one-third of its size.

THE CAPERCAILLIE IN SCOTLAND

The Capercaillie in Scotland. By J. A. Harvie-Brown, F.Z.S., Member of the British Ornithologist's Union. (Edinburgh: David Douglas, 1879.)

THE introduction of birds into countries far from their original homes and their successful "acclimatisation" therein—to use a word now generally in vogue—is well known to have been accomplished in many instances—not always, however, to lead to the benefits expected to result from it. Thus the European house-sparrow has been transplanted to the United States of America, and is now a familiar bird of many of the great cities of the New World; the Indian grakle is at present one of the commonest birds in Mauritius, and in some of the Hawaiian Islands the native birds are said to have almost entirely disappeared in the course of their struggles for life with introduced species. But the *re*-introduction of a bird into a country where it has formerly flourished and where it has only recently—almost within the memory of man—become extinct, is, so far as we know, almost an unparalleled fact, and one that is well worthy of an accurate record.

Such has been the case in our own islands with one of the finest and largest species of game birds commonly

known as the capercaillie, or cock of the woods—the *Tetrao urogallus* of naturalists—and Mr. Harvie-Brown tells us the story of its extinction and revival in the interesting volume now before us.

The capercaillie, as Mr. Harvie-Brown after much discussion, decides that the name is most correctly written, was certainly a not unfrequent denizen of the pine-woods of Scotland and Ireland in former days, but, for some not yet clearly understood reasons, became gradually rarer in both countries, and according to the best evidence was finally extinct between the years 1745 and 1760, although there are several records of its alleged occurrence in Scotland at a later date, which Mr. Harvie-Brown considers "at least worthy of notice." In 1807 a capercaillie is said to have been shot in the Camus-na-gaul woods opposite Fort William, but this must have been the last survivor of the ancient race, for it is allowed on all sides that at the beginning of the present century the capercaillie could no longer be reckoned as an existing "British bird." Its reintroduction was effected by the late Marquis of Breadalbane in 1837 and 1838, after several ineffectual attempts. Living birds obtained in Sweden through the instrumentality of Sir Thomas Fowell Buxton and by the energy of Mr. Lloyd, the well-known Swedish sportsman and naturalist, were transported to this country and safely delivered at Taymouth under the care of English gamekeepers. About forty-eight individuals were imported in these two years, some of which were turned out, while others were kept in captivity for breeding purposes. So well did they succeed that in 1862 or 1863 their numbers on the Breadalbane estates were estimated to be at least 1,000, whilst according to other accounts they reached at this period to over 2,000 in number. From the Taymouth woods the capercaillies spread gradually over the adjacent districts of Central Scotland, wherever fir-woods prevailed suitable to the habits and food of the bird. Mr. Harvie-Brown gives us details of their first appearance and present numbers on various estates in Perthshire, Forfarshire, Fife, Kinross, Clackmannan, and Stirling, besides other outlying counties. A neatly executed map enables us to realise at one glance the statistics that Mr. Harvie-Brown has so diligently collected. "The capercaillie then," he concludes, "has populated the woods and forests of part of Scotland principally by its own exertions, since the great restoration at Taymouth; but there are certain minor centres of introduction which have undoubtedly added *some* impulse to their advance, though perhaps not to any extent compared with the impulse from the great centre." All naturalists must, we are sure, feel indebted to Mr. Harvie-Brown for the pains he has taken in investigating this interesting subject, and will congratulate themselves upon the restoration of this noble species to the British avifauna.

OUR BOOK SHELF

San Remo and the Western Riviera, Climatically and Medically Considered. By Arthur Hill Hassall, M.D. (London: Longmans and Co., 1879.)

DR. HASSALL has written a really useful work on a part of the Italian coast possessing many points of interest, more especially to those affected with chest diseases. He himself has spent two winters in the Western Riviera, and during that period has diligently collected information by personal observation and otherwise on the spot. Partly in this way, and partly by consulting authorities on the topography of the district, and with the help of specialists in various departments of natural history, Dr. Hassall has compiled a work which may be taken as a full and trustworthy guide by all who wish to visit the Riviera either for pleasure or health. There are a few attractive illustrations and a good map.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

An Index to Zoological Genera

THE Smithsonian Institution at Washington will publish at an early day an index, in one alphabet, to all genera hitherto proposed in zoology, whether for recent or fossil animals. It is to be based upon the "Nomenclators" of Agassiz and Marschall and the indexes to the *Zoological Record*. The name of the genus will be followed by the name of its proposer, the order to which it is referred, the date of its publication, and the symbols **A.**, **M.**, **Z.**, or **App.** (to indicate that a full reference may be found in [**A.**] Agassiz's "Nomenclator," [**M.**] Marschall's "Nomenclator," [**Z.**] the *Zoological Record*, or [**App.**] the Appendix to the proposed work), thus:—

Donachlora, *Sodoffsky*, Mamm., 1837, **A.**
Dorcasia, *Gray*, Gaster., 1847, **M.**
Loganius, *Chapuis*, Coleopt., 1869, **Z.**
Periplacis, *Geyer*, Lepid., 1837, **App.**

Names to which objection has been raised will be prefixed by an asterisk.

The appendix referred to will record in greater detail names which have been overlooked in the lists above mentioned, or have been published since 1877, the year reviewed in the last *Zoological Record*.

The object of this communication is to invite *at once* from European zoologists, and especially from palæontologists, lists of such names as should appear in the appendix. Such names (including corrections of any kind to the text of Agassiz's or Marschall's Nomenclators) should be accompanied by the name of the proposer of the genus, full bibliographical reference, date, etymology, and the order of animals to which the genus is referable. *In the Index the name of the person furnishing the reference will also be added as its sponsor.*

Many American zoologists have promised their assistance, but it must be evident that a work so extensive and of such universal value can only be satisfactorily prepared by the aid of European naturalists. As it is expected that the MS. of the Index will be ready by December 1 next, friends of the plan are earnestly invited to communicate with the subscriber at the earliest possible day.

SAMUEL H. SCUDDER

Library of Harvard University, Cambridge,
U.S.A., September 22

The Mineral Waters of Hungary

THE numerous mineral waters of Hungary, some of which are used as table-waters, while others are prized for their medicinal properties, are unfortunately very imperfectly known either to the scientific world or the general public, and, what is worse, many of the particulars which have been published about them are altogether incorrect and misleading.

There are a number of balneological works treating of the European mineral springs generally, which include descriptions of those of Hungary, but in almost all cases these descriptions are either obsolete or unreliable. That such incorrect statements should appear in the works of foreigners is perhaps excusable, when we consider the difficulties under which the authors must labour in seeking to obtain information upon the subject; but we may fairly expect that a work published in Hungary should be without any such serious errors. It is a most unfortunate

circumstance that a work bearing the title "Les Eaux Minerales de la Hongrie," published under the auspices of the Hungarian Commission of the last Paris Exhibition, and very extensively circulated by them, is found upon examination to be altogether unreliable in its information. In the interests of truth I feel called upon to point out to foreigners the unsatisfactory nature of this work. This condemnation of the work in question is borne out by the following facts:—The book enumerates less than forty per cent. of the localities in Hungary at which mineral springs occur, no fewer than a thousand of such localities being omitted. Perhaps it is by way of compensating for these omissions that the anonymous author augments his list by making two or three mineral springs out of one by not discriminating its synonyms, and also by enumerating others which have no real existence. In many cases the author has failed to indicate the localities to which his information refers, especially in those instances in which there are several places of the same name; and these difficulties are increased by the numerous typographical errors in the book. The analyses published in the work are of a very unsatisfactory character, for while more than one hundred of the most recent and valuable analyses are altogether omitted, others, which were made twenty or thirty years ago, and are therefore far less reliable, are included in it.

Although it cannot be expected that a large class of readers should take an interest in these details about the Hungarian mineral waters, yet I have thought it right to point out the unreliable character of this work in your widely-circulated journal, so that the errors should not be transferred to the pages of balneological works of a more general character. To the authors of such works I should be glad to furnish information concerning the mineral waters of this country, as it is a subject which I have made my especial study. J. BERNÁTH

Buda-Pest

Does Sargassum Vegetate in the Open Sea?

IT is related by Humboldt and Harvey that floating *Sargassum bacciferum* vegetates in the open sea, by sprouting branches without fructification, whilst other naturalists have seen in the yellowish floating pieces only the pale and altered dead remains of the plant. If these floating fragments were capable of vegetating, their branches should be brown or olive-coloured like living specimens on the rocks below water on the sea-shore, and if floating Sargassum really grow, fructification should not be wanting.

I have heard from several travellers, who have sometimes crossed the Sargasso Sea, that they, like me, never saw other than pale and dead floating sargassum, so that I believe those accounts of Humboldt and Harvey to be erroneous. Does any reader of NATURE know of living Sargassum in the open sea as a fact?

There exist many fanciful reports on Sargassum, *e.g.*, that some branches of the floating Sargassum rise two inches above water, and are thus driven along by the wind. Can any one confirm this? No botanist has hitherto observed it, and no sea-weed is known to behave thus. Haeckel and other learned men who never crossed the Sargasso Sea, speak of "a colossal sea-weed forest of 40,000 geographical square miles."

I would be greatly indebted for exact information as to the degree of density in which Sargassum has been observed. Although I was eleven days crossing in a steamer the two great seas containing Sargassum, I saw nothing at all in the Pacific on the direct route from San Francisco to Yokohama; and in the Atlantic I observed only single fragments from 50 to 100 feet apart; other credible travellers assure me of having seen the Sargassum sometimes almost grouped together in loose masses or strips of about 400 feet in length, hardly at all entangled and of no depth. I doubt therefore, also, whether Sargassum could hinder sailing vessels. OTTO KUNTZE

Leipzig-Eutritzsch, September 30

[In Dr. Kuntze's letter, vol. xx. p. 426, line 4, read: "In Eozöon they became;" line 31, "under red heat;" line 40, condensed, not into incandescent liquids, but into incandescent crystals; line 44, "granate" ("garnet," not "granite").]

A Liquid Rheostat

WHILE experimenting on resistance to the electric current, I have devised an instrument in which fluid is used to conduct the current under examination. This may perhaps be of use to some who are interested in this subject. The sketch, Fig. 1, shows the nature of the instrument. A B is a piece of elastic tube containing a weak solution of salt in water; this is held in the clamp C. By the screw D the tube can be compressed and its sectional area altered, and through this its resistance. G is the galvanometer and E the battery. Finding the instrument to

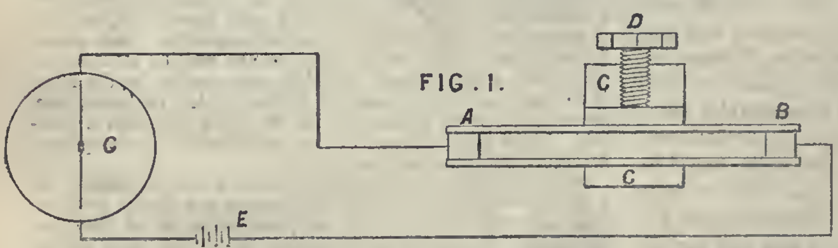


FIG. 1.

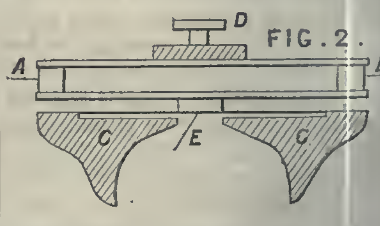


FIG. 2.

be very sensitive on a reflecting galvanometer I thought that probably the tube would be a means of transmitting articulate speech. I find this to be the case. Fig. 2, A B, elastic tube similar to the one used in the former instrument; C C, mouthpiece; E, disk, connected to the tube at E. A B is put in circuit with a telephone and battery; D, screw to regulate the pressure on the tube. I call the instrument, Fig. 1, a liquid rheostat.

Taunton, September 24 FREDERICK JOHN SMITH

The Carving of Valleys

MR. WALTER R. BROWNE tells us in NATURE, vol. xx. p. 504, that he has discovered in the valley of a highland burn evidence that "the agencies of 'sub-aërial waste' are seen to have worked their will for untold ages on the Cambrian sandstones of Glen Beansdale, and to have produced—nothing."

Without making any attempt to explain how the old river channel he describes is not "choked by the *débris* which has come down from its sides," further than to suggest that "the tiny runnel which now drains the gulley" may sometimes be, not the little streamlet which Mr. Browne saw, but a great roaring torrent quite capable of "direct erosion of its own, and of sweeping away the *débris*" which may have tumbled into it from its sides, it appears to me remarkable that evidence *against* sub-aërial denudation should be brought from the Scottish highlands where every mountain and valley seem to testify eloquently in its favour. I am pretty familiar with a great part of the northern highlands, and I do not remember a single mountain which does not bear on its flanks ample evidence of the energy of this form of erosion. It is now some years since I have been at Loch Maree, but if I am not greatly mistaken Ben Slioch itself is draped in loose angular fragments, the result of its own decay. If Mr. Browne, while in these regions, visited Glen Sligachan, in Skye, he must have found that wherever he walked in that wild valley, it was on fragments of rock that have not only slid down the mountain sides in vast torrents, but spread out over the whole floor of the glen, burying the original glaciated surface deep beneath them; and in all parts of the more southern and central highlands we find the same irresistible evidence of the continued waste of the hillsides by heat and cold and the rainfall.

As to the behaviour of streams in excavating valleys, very much depends upon the character and arrangement of the rocks over which the river flows; there are many streams in both

highlands and lowlands which in one part of their course have cut deep vertical gorges not unlike cañons, while at another they have scooped out wide open valleys with gently sloping sides, so to come to any conclusion based on the assumption that the eroding action of streams is uniform is very unsafe.

Mr. Browne seems also to take a very peculiar view of the extent of the ancient glaciers, as he speaks of the channel of the little stream he describes as "sufficient to guide the glacier in its flow," seeing that the great glacier which flowed over Scotland from north-west to south-east took no notice of such a channel in its course as the Firth of Tay, but swept over it and the county of Fife beyond, scarcely showing a trace of being deflected at all. Surely there could not be such an enormous difference in the dimensions of the glaciers on the opposite coast as this would indicate. Whatever was the case on Loch Maree, the glaciers that moved down Loch Assynt and Loch Broom were no pigmies.

JAS. DURHAM

Newport, Fife, September 27

The Bis-cobra, the Goh-sámp, and the Scorpion

SNAKES of all kinds are held in great horror by the natives of India, and they slay indiscriminately and ruthlessly all they come across, but this horror pales before the terror inspired even by the names of the bis-cobra and goh-sámp,—terror so great, that, if met with, the harmless animals are given the widest berth possible, and their destruction is never attempted. Though actual animals, they are virtually mythical, that is as regards the deadly properties assigned to them, and we easily recognise in them the originals of the flame-breathing dragon and deadly basilisk. The gaze of the bis-cobra is awful even from a distance and its bite is instant death; and if the goh-sámp breathes upon, or at you, you fall dead at once.

With such awful reputations attached to them, I lost no time, in my early career, in attempting to make the acquaintance of these formidable reptiles, and, after much labour, succeeded.

No one would help me in procuring a bis-cobra, and my servants repeatedly warned me against the risk and madness of the attempt. At one time I had engaged the services of a savage woodsman in collecting birds' eggs, and to him I, one day, applied for a bis-cobra, but he at first refused, and it was only the promise of large bakhsheesh that ultimately induced him to promise his assistance. After several days he appeared carrying an earthen pot at the end of a long bamboo, and meeting me, whispered mysteriously in my ear "Sahib! bis-cobra!" Glad of the news, I summoned my servants, who, when they heard the reason of the summons, reluctantly formed a distant semicircle. The pásee cautiously put down the pot and also retired to a distance. In no way dismayed, I approached the pot, removed the dirty rag around its mouth and looked in. As expected, I found a beautiful brown and yellow lizard, freely protruding in its fear a forked anguine tongue, and anxious to escape. On taking it up it seized my hand with its delicate teeth, and in this position I held it up to the horror-stricken servants who exclaimed in fear "Sahib! sahib! chōr do, pheak do (Master! master! let (it) go, throw (it) away)." Then, on my declining to do either, they, like the barbarians of old, waited anxiously to see whether I "should have swollen or fallen down dead suddenly," and, seeing no harm, they quietly dispersed.

My adventure with the goh-sámp was unsought and equally satisfactory.

Walking in my garden one day, I met the gardener running away with affrighted look from a pear tree, and asked the reason; he could only gasp out "Goh-sámp, sahib, goh-sámp!" and implore my return. Delighted at the opportunity, I pressed on, and soon saw the awful reptile trying to dodge my gaze; a large scaly, uncanny looking tree lizard about fourteen inches long. In the distance the mali (gardener) implored me to beware his "phoonk" (blast of breath), but I courted it, by trying to dislodge him, which I succeeded in doing by shaking the bough, and then he threw himself on the ground and scuttled up another tree. Both lizards are absolutely harmless, and I believe a poisonous lizard is quite unknown.

The scorpion is not dreaded like the snake, but, like it, is inevitably killed. Its habits and pursuits well deserve study; my observance of the former has enabled me to clear away (to my own satisfaction) many obscurities with regard to its poison weapon and the mode of using it. And let me declare at once that the popular idea regarding scorpionic suicide is a delusion based on impossibility. Owing to the position and nature of its weapon, the animal cannot strike itself. It does not protrude a sting as bees, *et hoc genus omne*, do, and the line of strike is downwards and backwards, with at times a lateral but yet downward motion. As literally described in Holy Writ, *it strikes but does not sting;* and its motion in so doing may be imitated by seizing the tip of the index or middle finger with the thumb, and suddenly liberating the former.

The poison is acid and albuminous; the latter I presume, as on placing a living specimen in spirit, the animal in its death throes ejected it, and it immediately coagulated in threads.

The pain and constitutional disturbance attendant on scorpion strike are often very severe, and children have occasionally succumbed; but adults only complain of the pain, which generally passes off in half-an-hour. On two occasions I have passed through a host of migrating crickets, once by day and once by night; on the first occasion my carriage wheels crunched for a mile through a cricket migration; and on the second my palkee bearers' feet slid about amid crushed crickets; on this occasion one of the bearers yelled out that a scorpion (out on a cricket spree) had struck his foot, and hobbled up to the palkee. Having the means at hand I applied a paste of ipecacuanha and laudanum, with almost immediate relief, and the bearer trudged on with the rest.

Peshawar H. F. HUTCHINSON

Certain Animal Poisons

I HAVE had unpleasant experiences of the poisonous properties of the Portuguese man-of-war, the great hornet, and the centipede.

While bathing at the Cape as a boy I managed to get the long lovely blue tentacle of the first round my wrist, and well recollect the attendant long-enduring agony and irritation, while the blue mark remained long on my wrist. Twenty-five years after, while soaking in a P. and O. steamer's marble bath in Madras roads, I suddenly received what seemed an agonizing stab below my left knee, and jumped out of the bath with the pain. The cause was at once apparent, a bit of the fatal blue filament had been pumped into the bath, and left the familiar mark on my knee, and I bore it for a long time.

On one occasion I was showing some friends over the famous "Arrah House" and opened a small window to let in more air and light; in doing so, I unwittingly disturbed the adhesions of a great hornet's nest, and one of the infuriated inmates at once stung me on the left temple; the pain was intense and the swelling immediate; aware of the constitutional disturbance which would follow, I made for home (about 500 yards distant), and reached the threshold of my drawing room, and there I was brought to an instant standstill, unable to move hand or foot, and trembling like an aspen leaf. I was laid on a sofa, and asked for a glass of port wine, which soon revived me.

This dreadful hornet, nearly two inches long, deep brown with a broad yellow band across the abdomen, builds large globular paper nests, and is not rare in the Himalayas, where it may often be seen in the pines. The hillmen dread it extremely, and with good reason, for a swarm, or even a few individuals will attack you fiercely and follow you for miles.

Griffs, who have fired at a nest, against the remonstrances of their hillmen, have paid dearly for their rashness. When attacked, the hillmen squat down and drawing their blankets closely around them, await the subsidence of the storm, rarely escaping two or three stings. I have known *one* of these hornets kill a child by its sting; and many horses have been destroyed by an infuriated swarm. These are the dreadful animals which assisted in the expulsion of the Amorites of old.

The common bee, which in India often builds in trees and ruins, frequently attacks men and horses, irritated by the smoke of the fires (for cooking) lighted under the trees or in the buildings, and a general *sauve qui peut* is the only mode of escape.

Many ludicrous adventures occur from this cause out here, and I will describe a recent one. The officers of a British regiment stationed at Umballa were dressing for Sunday morning Church parade, when the alarm was given in the compound of three who lived together, that the bees were abroad. As escape from the parade was impossible, and the infuriated bees had to be faced, the three griffs made a syce (horse attendant) envelope himself in a blanket, while each wrapped a sheet around himself, and then formed a line, the front officer holding on to the syce's bamboo, and the other two to one another's swords, and in this guise they groped their way out of the compound surrounded by

the angry bees; cautiously emerging from their sheets on the high road, the first person they encountered was their Colonel and his family driving to Church. The finale may be imagined!

I have always been fond of sleeping out during the hot weather, *sub Jove frigido*, or rather *torrido*, and used to have a sooráee (a porous earthen water bottle) capped by a tumbler, on the ground by my side.

One night I awoke to drink and, half awake, lifting the sooráee on to my naked knee proceeded to fill the tumbler. In a moment I felt as if a red hot poker had been freely applied to my knee, and, thinking that I had been stung by a snake, rushed into the house for a light, and a dose of sal volatile. I was now wide awake, and returned with the light to examine into matters, and then I found a large centipede coiled round the bottom of the sooráee, whither it had come for coolness or a drink, or both. It was six inches long. Judging from the size of the burn (for I bore the large red mark for many days), I inferred that I had not been bitten, but that the whole animal was acrid.

Peshawar H. F. HUTCHINSON

Spider's Web, New Caledonia

CONSUL LAYARD's account of the spiders' webs of the Polynesian Arachnids (NATURE, vol. xx. p. 456) reminds one of the colonial enthusiasm of certain fair ladies in Mauritius seventy years ago, previous to the capture of that island by General Abercrombie.

Throughout the Mascarene group are numerous species of *Araneideæ*, among which *Epeira inaurata* and *E. mauricia* are pre-eminent, their bright yellow webs being conspicuously stretched between the pointed leaves of the agaves and prickly-pears. Taking advantage of these "grandes toiles verticales à fils jaunes, soyeux et susceptibles d'être travaillés; sous le gouverneur-général Decaen, les dames créoles de l'île de France tissèrent avec les fils de ces belles aranéides une paire de gants dont elles firent hommage à l'impératrice." S. P. OLIVER

October 5

Change of Colour in Frogs

CAN any of your readers tell me if it is a fact that frogs change their colour before a change takes place in the weather?

A few days ago I was told at a village in Worcestershire, during heavy rain, that it would be fine to-morrow because a frog had been seen turning yellow. The fine weather came. I was informed that frogs become dark-coloured before wet weather sets in. W. J. CHAMBERLAYNE

Junior United Service Club, September 30

["The changes which the colour of the frog undergoes both in intensity and hue from the *variation of temperature, the presence and absence of light* . . . although certainly much less striking and considerable, are *scarcely less varied* than those exhibited by the chameleon."—Bell, "British Reptiles."]

SUBJECT-INDEXES TO TRANSACTIONS OF LEARNED SOCIETIES[1]

WE all remember the excellent paper read at the Oxford Conference by Mr. J. B. Bailey, sub-librarian at the Radcliffe Library, upon the advantage of a subject-index to scientific periodicals. Mr. Bailey spoke with just praise of the splendid alphabetical catalogue issued by the Royal Society, but observed that from the nature of the case this is "nearly useless in making a bibliography of any given subject, unless one is familiar with the names of all the authors who have written thereon." This is manifestly the case. As an illustration both of the value and the deficiencies of the Royal Society's index, I may mention that while on the one hand it has enabled me to discover that my father, chiefly celebrated as a philologist, has written a paper on the curious and perplexing subject of the formation of ice at the bottoms of rivers, the existence of which was wholly unknown to his family, it does not, on the other hand, assist me to ascertain, without a most tedious search, what other writers may have investigated the subject, or consequently how far his observations are in accordance with theirs. Multiply my little embarrassment by several hundred thousand, and you will have some idea of the amount of ignorance which the classified index suggested by Mr. Bailey would enlighten. We may well believe that the only objection he has heard alleged is the magnitude of the undertaking, and must sympathise with his conviction that, granting this, it still ought not to be put aside merely because it is difficult. I hope to point out, however, that so far as concerns the scientific papers, to which alone Mr. Bailey's proposal relates, the difficulty has been over-estimated, that the literary compilation need encounter no serious obstacle, and that the foundation might be laid in a short time by a single competent workman, such as Mr. Bailey himself. Of an index to literary papers I shall speak subsequently; and, there, I must acknowledge, the difficulties are much more formidable. But as regards scientific papers, it appears to me that the only considerable impediment is the financial. When the others are overcome, then, and not till then, we shall be in a favourable position for overcoming this also. The reason why the formation of a classified index to scientific papers is comparatively easy, is that the groundwork has been already provided by the alphabetical index of the Royal Society. We have the titles of all scientific papers from 1800 to 1865 before us, and shall soon have them to 1873. Though it might be interesting, it is not essential to go further back. We have now to consider how best to distribute this alphabetical series into a number of subject-indexes. To take the first step we merely require a little money (the first condition of success in most undertakings), and some leisure on the part of a gentleman competent to distinguish the grand primary divisions of scientific research from each other, and avoid the errors which cataloguers have been known to commit in classing the star-fish with constellations, and confusing Plato the philosopher with Plato a volcano in the moon. I need only say that very many of our body would bring far more than this necessary minimum of scientific knowledge to the task. I may instance Mr. Bailey himself. The money would be required to procure two copies of the alphabetical index (which, however, the Royal Society would very likely present), and to pay an assistant for cutting these two copies up into strips, each strip containing a single entry of a scientific paper, and pasting the same upon cardboard. It would be necessary to have two copies of the alphabetical catalogue, as this is printed on both sides of the paper; and as the name of the writer is not repeated at the head of each of his contributions, and would therefore have to be written on the card, close supervision would be required, or else a very intelligent workman. When this was done, the entire catalogue would exist upon cards, in a movable form instead of an immovable. The work of the arranger or arrangers would now begin. All that he or they would have to do would be to write somewhere upon the card, say in the left hand upper corner, the name of the broad scientific division, such as astronomy, meteorology, geology, to which the printed title pasted upon the card appertained, and to put each into a box appropriated to its special subject, preserving the alphabetical order of each division. We should then have the classed index already in the rough, at a very small relative expenditure of time, money, and labour. For the purposes of science, however, a more minute subdivision would be necessary. Here the functions of our Council would come into play, and it would have a great opportunity of demonstrating its usefulness as an organising body by inducing, whether by negotiation with individuals or with scientific corporations like the Royal Society, competent men of science to undertake the task of classifying the papers relating to

[1] By Richard Garnett, Superintendent of the Reading Room, British Museum. Read at the March monthly meeting of the Library Association of the United Kingdom. Contributed by the Author.

their own special studies. Men of science, we may be certain, are fully aware of the importance of the undertaking, which is indeed designed for their special benefit; and although they are a hard-worked race, I do not question that a sufficient number of volunteers would be forthcoming. When one looks, for example, at the immense labour of costly and unremunerated research undertaken by a man like the late Mr. Carrington, one cannot doubt that men will be found to undertake the humbler but scarcely less useful and infinitely less onerous task of making the discoveries of the Carringtons generally available. I am sure, for instance, that such men as Mr. Knobel and Mr. Carruthers would most readily undertake the classification of the astronomical and the botanical departments respectively, provided that their other engagements allowed, as to which, of course, I cannot affirm anything. Supposing our scientific editors found, they would proceed exactly in the same manner as the editor who had already accomplished the classification in the rough. Each would take the cards belonging to his own section, and would write opposite to the general subject title written by the first classifier the heading of the minor sub-section to which he thought it ought to be referred; thus, opposite Botany—Lichen, and so on. He would then put the title into the box or drawer belonging to its sub-section, and when the work was complete we should have the whole catalogue in a classified form, digested under a number of sub-headings. Some preliminary concert among the scientific editors would, no doubt, be necessary, and a final revision in conformity with settled rules. It might be questioned, for example, whether a dissertation on camphor properly belonged to botany, chemistry, or materia medica; whether the subject of the gymnotus was ichthyological, anatomical, or electrical; whether in such dubious cases a paper should be entered more than once. It would save time and trouble if these points could be determined before the classification in the rough was commenced; in any case considerable delay from unavoidable causes must be anticipated. It is to be remembered, on the other hand, that the work could, under no circumstances, be completed until the publication of the Royal Society's alphabetical index of papers from 1865 to 1873 was finished, which, I suppose, will not be the case for two or three years. There will, therefore, be sufficient time to meet unforeseen causes of delay. If the classified index could be ready shortly after the alphabetical, if we could show the world that the work was not merely talked about as desirable, but actually done in so far as depended upon ourselves and the representatives of science; that it already existed in the shape of a card catalogue, and needed nothing but money to be made accessible to everybody—then we should be in a very different position from that which we occupy at present. I cannot think that so much good work would be allowed to be lost. The catalogue, not being confined to papers in the English language, would be equally useful in every country where science is cultivated, and would find support all over the civilised world. Either from the Government, or from learned societies, or the universities, or the enterprise of publishers, or the interest of individual subscribers, or private munificence, means would, sooner or later, be forthcoming to bring the work out, and thus erect a most substantial monument to the utility of our Association. It would obviously be important to provide that scientific papers should be indexed not only for the past, but for the future. If, as I trust, the Royal Society intends to continue the publication of its alphabetical index from time to time, the compilers of the classified index will continue to enjoy the same facilities as at present. There must be some very effectual machinery at the Society for registering new scientific papers as they are published. What it is we may hope to learn from our colleague, its eminent librarian, who must be the most competent of all authorities on the subject. Mr. Bailey draws attention to several scientific periodicals as useful for bibliographical purposes, and I may mention one which seems to be very complete.[1] It is published at Rome. The number for last December, which I have just seen, is so complete that, among a very great number of scientific papers from all quarters, it records those on the telephone and the electric light, in the "Companion to the British Almanac," which, I think, had then been only announced here, not published, omitting the other contributions as non-scientific. It further gives a complete index to the contents of the *Revista Cientifica*, a Barcelona periodical, which had apparently just reached the editor, from its commencement in the preceding April. By this list I learn that the electric pen, the subject of our colleague Mr. Frost's recent paper, had been the theme of a communication to a Barcelona society in May last. It certainly seems as if any library that took this periodical in, and transcribed the entries in its bibliographical section on cards properly classed, would be able to keep up a pretty fair subject-index to scientific papers for the future. I must, in conclusion, say a few words on a subject-index to the transactions of literary societies. The prospect is here much more remote, from the want of the almost indispensable ground-work of a general alphabetical index. We have seen what an infinity of trouble in collecting, in cataloguing, and in transcribing will be saved by the Royal Society's list in the case of scientific papers, and are in a position to appreciate the impediments which must arise from the want of one in this instance. The work could be done by the British Museum if it had a proportionate addition to its staff, or by a continuance of the disinterested efforts which are now devoted to the continuation of Mr. Poole's index to periodicals. Failing these, the most practical suggestion appears to me Mr. Bailey's, that the undertaking might be to a considerable extent promoted by the respective societies themselves. If the secretaries of the more important of these bodies would cause the titles of the papers occurring in their transactions to be transcribed upon cards and deposited with this Association, we should accumulate a mass of material worth working upon, and which might be arranged while awaiting a favourable opportunitity for publication. In some instances even more might be done. The library of the Royal Asiatic Society, for example, contains not merely its own transactions, but those of every important society devoted to Oriental studies, as well as all similar periodicals. Our friend, Mr. Vaux, could probably, in process of time, not only procure transcripts of the papers contained in these collections, but could induce competent Orientalists to prepare a scheme of classification, and such a classified list, complete in itself and of no unwieldy magnitude, could be published as a sample and forerunner of the rest. The initiative in such proposals, as well as those referring to scientific papers, should be taken by our Association, which can negotiate with eminent men and learned bodies upon equal terms, and speak with effect where the voice of an individual would be lost. The desideratum of a classed index, in a word, affords our Society a great opportunity of distinguishing itself. It is this aspect of the matter, no less than the importance of the matter itself that has encouraged me to bring it under your notice.

ON VARIABLE STARS

IT had long been known that certain stars greatly varied in brightness and some observations had been made concerning them, but it was reserved to the Herschels to pave the way for practical investigators. Notwithstand-

[1] *Bullettino di bibliografia e di storia delle scienze matematiche e fisiche.* Pubbl. da B. Boncompagni; Rome, 1868, &c.

ing the importance of the results which the observation of them bids fair to offer concerning the nature of the sidereal universe, the variable stars have not attracted so much attention as other even less important phenomena in the starry heavens, and one cause of this must be sought in the circumstance, that most of these observations are best made with very small telescopes or even with the naked eye, and while it is the duty of the professional astronomer to make use of the expensive instruments, of which he has charge, the inclination of the amateur astronomer in this country often leads him in the same direction. However, the attention of those who take an interest in the science but cannot afford a large outlay, cannot too often be urged towards this kind of observation, that while it so much needs their help is so thoroughly within their reach.

The best method is due to Argelander, a follower of Bessel, who was considered the first authority on the subject during his lifetime. It was propounded in his "Aufforderung an Freunde der Astronomie zur Anstellung von eben so interessanten und nützlichen, als leicht auszuführenden Beobachtungen über mehrere wichtige Zweige der Himmelskunde," which appeared in Schumacher's *Jahrbuch für* 1844, a periodical seldom met with in this country, which may in a measure explain the comparatively little attention that has been given to this subject on the part of British amateurs, who have so energetically followed up more complicated investigations. The success of those who have spent even a short time on these observations may be considered a sufficient appeal, and we venture to hope that the following short sketch of the easiest and most convenient method will be acceptable to some of the readers of NATURE who have not Argelander's lengthy paper at hand. The observations are in reality far simpler than the description of them looks. The stars visible to the naked eye are arranged in six classes according to their brightness, but it is often doubtful to what magnitude we shall refer an object, because we are able to judge about much smaller differences than those that distinguish two magnitudes, the number of which is therefore too small. The smallest difference perceptible to the average sight is a tenth of a magnitude, and we are therefore able, by a method of sequences, to reach a considerable accuracy. Researches on variables have further this advantage that we do not want to know the absolute magnitude but only the brightness relatively to certain other stars. These comparison-stars must be chosen with intervals of not above a half magnitude, and be situated as near the variable as they can be had, for the transparency of the air is often different not only in different altitudes, but also in different azimuths—nay even owing to aqueous vapour and chemical causes at times in the same place. Observations near the horizon should be avoided, and near the zenith the position is difficult. Twilight, moonlight, and lamplight would likewise interfere, and above all it must be avoided to observe from a lighted room. Against the moon or a distant gas-lamp in a town a screen can be used. If clouds are near they will render the comparisons uncertain. Cirro-stratus commencing to descend from high in the atmosphere is particularly deceiving. The estimation of stars of the first magnitude is difficult, and an evenly illuminated background in this case rather an advantage, or a slight fog, but in the latter case and when detached clouds are on the sky the observations have to be repeated with an interval of a few minutes, because fogs are rather irregular; at other times an observation may be secured in a few minutes, and more observations the same night are only required in case of quickly changing stars. They generally give identical results, but two or more observers are an advantage, though their estimations may have constant differences, because various colours affect individual eyes differently. No attempt need be made to look simultaneously at both stars, because the sensibility of the eye in different spots is different, and this error would not be eliminated. Look first at one star, then turn quickly to the other, look at that and return to the first again. It is well to turn the eye a little to the side, when watching a star. It appears then brighter, because the middle of the retina is tired with constant work. The comparison of stars barely visible is to be avoided. The results, together with the nature of the circumstances, should be noted at once, and in the dark. It will be remarked that the causes of error, referred to above, are not sensibly removed by using photometers, and other errors may be introduced by such complicated apparatus. Faint stars may be observed through a binocular. The glass used should be colourless, always the same, and the distance between the eye-glasses carefully adjusted. It must be confessed that this kind of work cannot be carried out in places where the sky does often not clear for months, as in North-West Ireland; on the other hand the English climate seems favourable. It is often blue sky, if only partly, and no superior definition is required. At present this part of astronomy is mainly dependent upon the labours of Julius Schmidt, of Athens. Some knowledge of the constellations is necessary, and that may be gained from Argelander's or Heis's Uranometries. In case the research be extended to telescopic stars Argelander's large atlas should be procured. It is known that Pogson at Hartwell and Madras has made diagrams of stars round the variables, which would be very useful.

The differences are noted in "steps," each of which is equal to a tenth of a magnitude. If the comparisons are doubtful but most give one star, a, larger than another, b, it is said that a is one step above b : $a\,1\,b$. If at all times a seems larger than b, it is two steps above it : $a\,2\,b$. If the difference is remarked at a glance, a is three steps above b : $a\,3\,b$. Still greater difference is denoted $a\,4\,b$, which is occasionally used, though so great a difference cannot be estimated so exactly as a smaller one, the probable error of which is much below one step, so that it is preferable to give the comparisons in half steps. For exercise Argelander's comparison stars can be used from "Astronomische Beobachtungen auf der Sternwarte zu Bonn," vol. vii., 1869. The steps might not be exactly identical in all cases, but they ought not to deviate much. The variable should not only be compared with the greater and smaller star but also with the mean of them, which is very accurate. From each comparison follows then the brightness of the variable, and the average of these is taken first in the common manner, next allowing weights inversely proportional to the number of steps, and the means of the two is assumed as the definitive result. Of course this is more estimated than computed, and the two results agree generally.

From magnitudes thus obtained in a scale of steps the epochs of maxima and minima are next sought, from which follows the period, which is the principal element. When a sufficient number of periods are available it can be seen whether this is constant, and if not, one must try to find a formula which will give the length at any time. A good many periods are about 300 days, but many only a few days. The brightness in the two principal phases will generally be found irregular if the period be so. Some stars have more than two maxima and minima during the same period. Next we project on a paper ruled in squares the brightness of the variable with the time as abscissa, counted from the nearest preceding maximum and expressed in parts of the respective period. The curve drawn as nearly as possible through the points, whose weights may be indicated by circles round them, is called the light curve, and on that we can read off the brightness for any moment, but it is not always possible to treat the observations thus *en masse;* sometimes single periods have to be separately discussed, and indeed when it is great we can arrive at some results from a single

period, but if it is short many revolutions must be watched. These stars proceed more quickly from minimum to maximum than from maximum to minimum, and this is also the case with new stars. At last it is found that the colour is most monochromatic nearest the minimum. The brightness of the comparison stars is best obtained from their comparison with the variable and become therefore better known the more revolutions are watched. The final discussion will sometimes show that one or more of the comparison stars are variable themselves, for astronomers agree that there are many more variable stars in the sky than those contained in the catalogues.

As to the physical explanation of these phenomena we do not learn much from Argelander, who was one of the last champions of the old school. It is even said about him that he to the last stuck to Herschel's theory of the structure of the sun in spite of this being opposed to Newton's axioms, and framed, according to the now obsolete assumption, that every heavenly body ought somehow to furnish a comfortable abode for beings like ourselves. We can only comprehend unknown things from what is already known to us, and it is therefore rational to suppose variable stars analogous to our sun, whose lustre must vary with the extent of its spots. It is no doubt reserved to the spectroscope to settle the question, meantime we can only keep in view Hind's important remark that variable stars are often of a ruddy colour, and appear surrounded by nebulosity at their minimum. W. D.

COFFEE-LEAF DISEASE OF CEYLON AND SOUTHERN INDIA

1. *HISTORICAL REMARKS.*—During the last ten years, the coffee plantations of Ceylon and Southern India have had to contend with a disease which has seriously affected their productiveness and entailed a heavy loss upon the proprietors. This disease, *Hemileia vastatrix*, popularly known as the coffee-leaf disease, was first observed in May, 1869, on a few plants in Madulsima, a newly-opened coffee district in the south-west of Ceylon, bordering on the low country. In July following, two or three acres were attacked, and from that time the disease has gradually spread, till, in 1873 all, or nearly all, the estates in the island were attacked by it. On the appearance of the disease in 1869, the distinguished fungologist, the Rev. M. J. Berkeley, determined its true character, and described it in the *Gardener's Chronicle* for 1869 (p. 1,157, with woodcut). It was found to be a fungus allied to the moulds, and named *Hemileia vastatrix*, B. and Br. It was subsequently described in the *Journal* of the Linnean Society ("Botany," vol. xiv. p. 93, pl. 3, Fig. 10), and a short notice appeared in the *Quarterly Journal of Microscopical Science*, 1873, pp. 79-81. In 1876 Dr. M. C. Cooke described and figured the disease from Indian specimens in the India Museum Report, 1876, pp. 4-6. More recently the Rev. R. Abbay, who, during several years residence in Ceylon, made this disease an object of special study, gave a fuller description of it, with the results of his observations upon the germination of the spores and their growth under artificial cultivation, in the *Journal* of the Linnean Society, 1878 ("Botany," vol. xvii. pp. 173-184, pl. 13 and 14).

In his first notice of the disease the Rev. M. J. Berkeley speaks of it as a "minute fungus which has caused some consternation amongst the coffee planters of Ceylon in consequence of the rapid progress it seems to be making amongst the coffee plants." He further remarks: "It is not only quite new, but with difficulty referable to any recognised section of fungi. Indeed, it seems just intermediate between true mould and Uredos, allied on the one hand to *Trichobasis*, and on the other to *Rhinotrichum*. Though the fungus is developed from the parenchyma of the leaf, there is not any covering to the little heaps, such as is so obvious in *Uredo* and its immediate allies, while the mode of attachment reminds one of *Rhinotrichum*." At that time no other form of *Hemileia* was known, and it was supposed to stand alone as the only species, and to be indigenous to Ceylon. Since then, another species of *Hemileia*, viz., *H. canthii*, B. and Br., has been found on a Ceylon jungle tree, *Canthium campanulatum*,[1] and lately Dr. Cooke appears to have met with a third species from Southern Africa.

Writing in 1874, Dr. Thwaites, the distinguished Director of the Botanic Gardens, Ceylon, describes the *Hemeleia vastatrix* as "a parasitic growth within the coffee tree of a well-defined species of fungus, originated and reproduced by means of spores, easily distinguished from every other known fungus." "There can be no question," he continues, "that this fungus is communicated from coffee plant to coffee plant through the dissemination of its spores, and that these may be conveyed by the wind, or by streams of water, or by animals of any kind moving from place to place." Though at first it was believed that some elements of the fungus were present "in the growing tissues of the coffee plant in a *diffused form*," this view was afterwards abandoned, further microscopical investigations having proved that the disease was mainly external, and "that the coffee tree suffered rather from exhaustion than from the poisoning of its juices." During 1873 and 1874 investigations of an important character were carried on by Dr. Thwaites and the Rev. R. Abbay, which led them to the conclusion that when grown upon charcoal kept constantly moist, the orange-coloured spores representing the fruit of the disease, gave rise to filaments more or less branched. At the termination of the branches "*secondary spores* appear to have been produced in the form of radiating necklace-shaped strings of little spherical bodies of uniform size, closely resembling the fructification of an *Aspergillus*."

2. *Effects produced.*—The effects of the fungus upon the coffee trees would seem to be the gradual loss of vital energy caused by repeated destruction of the leaves. The tree after the first attack of the disease, which is often apparently the most severe, throws out fresh, healthy-looking leaves, and exhibits for a certain period the appearance of having perfectly recovered. These fresh leaves, however, after the expiration of a few months, exhibit the characteristic spotting, and are sooner or later covered, on the under side, by orange-coloured dust representing the spores of the disease, and, as in the previous attack, fall prematurely. These repeated attacks at length seriously affect the health of the tree, which, if old and ill-cultivated, becomes of little or no value as a crop-producer.

The rapidity with which the disease was propagated after its first appearance, may be realised from the fact that although it was noticed only in one locality in May, 1869, it quickly spread to the neighbouring coffee-districts, and especially among native coffee, till in 1873 it was spoken of "as being found in nearly all, if not all, the estates in the island." The disease appears to have been noticed in India in 1869 and 1870, almost simultaneously with its appearance in Ceylon.[2] In February, 1874, its presence was seriously felt in Tellicherry, and it appears to have spread generally through the Wynaad and Mysore districts, and its first effects were so severe that it threatened to give a considerable check to coffee enterprise in Southern India.[3] In 1876 the disease appeared in Sumatra, and this year it has been found in the plantations of Java and Bencoolen; there can be little doubt, therefore, that the *Hemileia* is destined to be a wide-spreading and prevalent enemy in all coffee-producing areas of the East Indies.

The effects of the leaf-disease upon the exportation of

[1] "Enum. Plant. Zeylan. Rublaceæ," p. 153.
[2] Report of India Museum, M. C. Cooke, 1876.
[3] *Gardener's Chronicle*, February, 1874.

coffee from Ceylon, may be very distinctly traced. In 1869-70, before the disease had appeared generally upon the coffee plantations, Ceylon exported 1,009,206 cwts. of coffee, consisting of 860,707 cwts. plantation coffee, and 148,499 cwts. native coffee. In 1876-77, when there were 52,000 more acres in bearing, the total exports were only 797,763 cwts., viz., 727,420 cwts. plantation coffee, and 80,343 cwts. native coffee.[1]

The yield of native coffee[2] has been steadily declining since 1868, owing to the want of high cultivation and manuring which have, in some measure, at least, saved the plantation coffee from being subject to the full influences of the disease. The culmination of crop and total value for native coffee was reached in 1868, the year before the leaf disease appeared, when 218,584 cwt. were exported. In 1877 the export of native coffee had fallen to 76,182 cwts., only a little over a third of what it was in 1868.[3] The influence of the disease has also seriously reduced the yield per acre. The Rev. R. Abbay, in the paper mentioned above, states that "Previous to and including 1871 the average yield for five years over the whole island had been 4·5 cwt. per acre, whilst for the five succeeding years the average has only been 2·9 cwt. a decrease in the production of somewhat more than one-third."[4]

The deficiency in value of crop has been variously estimated; "the average annual deficiency in the whole island has been estimated by some as at least 2,000,000*l*. Since the 'disease' made its appearance in 1869, the coffee enterprise has suffered to the extent of from 12,000,000*l*. to 15,000,000*l*. in crops alone."[5] A portion of the loss which the coffee estates have suffered may be and is, no doubt, due to exceptionally unfavourable seasons for the blossoming and development of fruit, and to the fact that many unsuitable areas were planted with coffee, which have since become unproductive; but there is a marked difference in the uniform succession of crops and in the yield per acre since 1871, even in the best coffee districts, which is evidently attributable to the action of the coffee-leaf disease.

When the trees are severely attacked by "disease," there is a premature fall of leaf and a check to the growth, which invariably results in a partial loss of crop. The trees also appear much thinner than formerly, having a wiry, sickly look, and do not make new wood so rapidly. As the disease shows itself mostly in dry weather, and just before the crop is ripening, its effect upon the trees is more severe and lasting than it otherwise would be; the tips of the branches often die back, involving, as the tree does not ripen all the berries, a great percentage of light coffee and black-hearted beans. The vitality of the trees being thus yearly weakened, there is often a failure of blossom even in what may be called favourable seasons, for though the blossom is forced out, it finds insufficient food-supply to support it, and, consequently, a large and wonderful show of blossom often ends in a total or partial failure of crop.

It appears that during the earlier years of its ravages the disease, after a very severe attack, would so completely disappear, and the trees, relieved from its enfeebling effects, would put forth such an abundant supply of new wood and foliage that it was confidently hoped that it was only a passing visitation, and that it would soon and entirely pass away. Even now its attacks are often confined for some time to certain districts, and even to certain parts of estates, but it seems to be seldom absent from patches of old and ill-cultivated coffee, and from native gardens. It soon, however, became evident, in spite of its fugitive character, that though the disease did not completely kill any trees, its accumulative effects upon them, and especially on the older trees, were such that they could not be depended upon to ripen their crop or to produce, except in alternating periods, a moderately average crop. In 1874 Dr. Thwaites reported that "there is great reason to believe, from what has been observed, that high cultivation, with judicious manuring, enables the tree to better sustain the attacks of the fungus, and to retain strength and vigour enough to produce a fair yield of berry." Encouraged by this opinion, planters adopted manuring operations generally, not as a cure for leaf disease, but in order to strengthen the trees and enable them the better to bear the double strain induced by crop and leaf disease. Though to some extent successful, it was noticed that, with the leaf disease present, the effects of manuring were not nearly so lasting as formerly, and were seldom apparent after the first or second year. There was also a less ready response on the part of the trees, and cases were not infrequent where trees had almost died out when forced to produce heavy crops, and others, where trees in a large degree had ceased to yield to any stimulus whatever.

3. *Remedial Measures*.—From what has been already mentioned it may naturally be supposed that the coffee-leaf disease and its effect on coffee cultivation in the East have occupied considerable attention during the last ten years, and, indeed, it may be looked upon as the most pressing and momentous of all questions affecting the prosperity and welfare of Ceylon, which depends so largely upon its coffee enterprise. Many suggestions have been made from time to time with regard to the application of suitable and effective remedies. As early as 1869 the Rev. M. J. Berkeley recommended the use of flowers of sulphur, or "one of the sulphurous solutions recommended for the extirpation of the hop-mildew," but the fugitive and deceptive nature of the disease and the vast area (over 200,000 acres) to be treated prevented any decided steps being then taken.

The hopes that were entertained respecting the temporary nature of the visitation and its possible mitigation by the application of suitable manures also led planters to look to indirect rather than direct means for checking the ravages of the disease. A few experiments were initiated, but from an imperfect knowledge of the disease and want of suitable apparatus no satisfactory results were obtained.

In January of this year a series of systematic experiments were initiated at Wallaha Estate, Lindula, in conjunction with the Hon. G. A. Talbot. In these experiments advantage was taken of the fact that the disease in its first or filamentous stage appears to exist as an *external* parasite upon the leaves and branches. It was found experimentally that an application of flowers of sulphur and coral lime entirely destroyed these external mycelial threads and without inflicting the slightest injury even to the most delicate parts of the plant.

This fact fully established, and being confirmed by subsequent experiments on larger areas, gave an entirely new aspect to the subject, and the present year has been signalised by an earnest and it is to be hoped a successful attempt to reduce the ravages of the coffee-leaf disease.

As sulphur had been used so extensively and so successfully against fungoid parasites in other parts of the world it may appear a matter of surprise that no steps had been taken long before this to test its efficacy on the coffee plant. In order to treat this disease successfully, however, it appears to be indispensable to carefully watch its various stages and apply specifics only when the disease is mostly external. During several months of the year, especially during a continuance of wet weather, the *vegetative* system of the *Hemileia* seems mostly to be developed, and as the mycelial threads are present *externally* upon the branches and leaves, it offers a favourable means for being treated.

Unfortunately the disease during this stage is entirely

[1] "Ferguson's Directory of Ceylon," 1876-78 Introd.
[2] Unpruned coffee grows with little or no cultivation in Sinhalese gardens.
[3] The falling off in native coffee is possibly not quite so much as these figures would indicate, for latterly an increasing quantity of native garden parchment is shipped as plantation coffee.
[4] Linnean Society's *Journal* "Botany," vol. xvii. pp. 173-5. [5] *Ibid.*

microscopical, and it requires very close observation even with the microscope to detect it. It is no wonder, therefore, that planters found it most difficult to decide when and how to apply remedies, and these considerations, together with others incidental to coffee cultivation, rendered a successful treatment, without scientific aid, both difficult and laborious.

When the results of the first experiments at Wallaba were published, the importance of the subject led the Colonial Government to take up further investigations, and to render special scientific aid to the planters in conducting their experiments. Experiments were organised on a large scale, and carried on in various districts throughout the island.

Meetings were also held, in which the development of the disease, and the results of more extended experiments and observations were given in detail.

As a result of this combined activity, a series of reports has lately been presented to the Legislative Council of Ceylon, embodying the results of the "Leaf-disease Inquiry;" these are published in the Sessional papers of this year. The results of the investigations, so far, are briefly summed up as follows:—

1. That the coffee-leaf disease is an organised fungoid growth, present on the estates in some form or other all the year round.

2. That in December and the early part of the year it is generally present as an external parasite upon the coffee trees, in the form of long filamentous threads which cover every part of the bark and leaves.

3. That while an external parasite and in the filamentous stage it is possible to destroy it most effectually, and by so doing to save the trees from the attacks of the fungus for at least one year.

4. That a mixture of sulphur and lime dusted by hand into the tree in the proportions of one of sulphur to two of lime has been found by experiment to be the most effective and suitable remedy which can be applied.

5. That the cost of the materials, at present prices *in Colombo*, together with the cost of application, will not exceed at the rate of R16·50 per acre.

6. That the application of sulphur and lime in the proportions recommended, by releasing the trees from a heavy drain upon their resources and restoring them to their natural condition, will be attended by a much more profitable result than any expenditure upon artificial manures.

7. That in order to assist the means used for checking the leaf disease it is most important that planters unite in the application of remedies and that they remove at once all sickly trees on their estates and those not likely to be crop producers, and prevent by every means in their power the re-infection of good coffee.

8. That in order to secure *perfect* freedom from leaf-disease it will no doubt be necessary to uproot all coffee trees on abandoned estates and old native gardens, and to take steps to prevent the disease from finding an asylum upon any plants not under careful cultivation.[1]

Judging by these results, which have been obtained by the united action of practical men of considerable knowledge and experience in coffee cultivation, aided by careful scientific observation, there is little doubt that the leaf disease can now be very effectually and conveniently treated, and if not completely exterminated, at least so materially reduced that it will not seriously injure the crops.

In the reports just quoted, great prominence is given to the necessity which exists for removing all old and sickly trees and up-rooting coffee plants growing without care or cultivation on abandoned estates and native gardens. Such trees appear to be the worst sufferers from leaf disease, and while they remain, are a continual source of danger to well-cultivated estates. One severely diseased tree is said to be sufficient to infect all trees in its immediate neighbourhood, and on that account a strong conviction is expressed in the Reports that little good can be expected from remedial measures of any kind, unless great care is taken to prevent the disease finding an asylum on "shuck" and abandoned coffee. The earnestness and intelligence which have characterised the action of the planters during the recent experiments lead to the hope that every means will be taken to check the development of the disease, and to increase the action of suitable remedies. The Reports also recommend the extended cultivation of other plants, such as tea and cinchona, in order to break the continuity of the coffee estates and restrict the action of the disease as much as possible.

On thus reviewing the present condition of coffee cultivation in Ceylon, there is much that is hopeful and satisfactory. Dr. Thwaites in his Report dated March, 1877, remarks that "Notwithstanding the continued prevalence of *Hemileia vastatrix* upon the coffee plants throughout the island, there would appear to be little, if any, diminution in the anxiety to invest in the cultivation of coffee; the high prices obtained, and the beneficial effects of judicious manuring, are giving so much confidence to planters." This feeling appears still to be maintained, for keen competition and high prices characterise all recent sales of suitable forest land. And while this shows that coffee cultivation still possesses the confidence of investors in new districts, many estates even in the oldest districts, are sold at prices which show they possess great vitality, and that where careful and intelligent cultivation is pursued they still offer a promising and attractive investment. It is gratifying to find that the planters are now quite conscious of the true nature of the disease, and thoroughly aroused to the necessity which exists for treating it on the lines which have proved so eminently successful for the last twenty years with the fungoid pests of the hop and vine.

By the extended cultivation of cinchona, tea, and other products, some of the conditions which have induced, or, at least, encouraged the ravages of the leaf-disease, will doubtless be removed, and in the renewed care and intelligence which are becoming daily more apparent in the methods of cultivation and the application of suitable manures, there is every reason to believe that coffee cultivation in Ceylon will be carried on under much more advantageous circumstances than at present, and while much that is now under coffee will probably be planted with tea and cinchona, the remaining lands will receive that due care and attention which cannot fail in time to restore the coffee estates of Ceylon to the position they have long held as one of the most successful and important of the enterprises of the East.

D. MORRIS

Kew, September 3

[1] Morris's Reports on "Coffee-Leaf Disease," Sessional Papers, Legislative Council of Ceylon, 1879.

OUR ASTRONOMICAL COLUMN

THE SATELLITES OF MARS.—In the Introduction to his Tables of the satellites of Uranus, Prof. Newcomb points out the advantage that might be derived, in systematic observations of the satellites by the preparation of a table showing the angles of position and distances corresponding to every 10° in u or the longitude of the satellite in its orbit, counted from the point in which it crosses the plane parallel to the earth's equator. From such a table the approximate positions of the satellites would be obtainable at any one opposition, with no further calculation than is required to determine the value of u for the time of observation. The more rapid geocentric motion of the planet Mars does not of course allow of this principle of computation being applied so as to attain the same degree of approximation as in the case of Uranus, but even with Mars it is likely that such a table, prepared with the values of the various auxiliary quantities for the date of opposition November 12, may facilitate observations, and we accordingly present one below:—

Argument u.		Position.		Distance.	
A.	B.	A.	B.	*Deimos.*	*Phobos.*
°	°	°	°	″	″
0	180	178·8	358·8	20·4	8·2
10	190	144·5	324·5	16·8	6·7
20	200	109·3	289·3	19·9	8·0
30	210	88·4	268·4	27·3	10·9
40	220	77·0	257·0	35·8	14·3
50	230	70·1	250·1	44·2	17·7
60	240	65·3	245·3	51·6	20·7
70	250	61·4	241·4	57·7	23·1
80	260	58·4	238·4	62·3	25·0
90	270	55·6	235·6	65·2	26·1
100	280	53·1	233·1	66·2	26·5
110	290	50·5	230·5	65·1	26·2
120	300	47·8	227·8	62·6	25·1
130	310	44·8	224·8	58·0	23·3
140	320	41·1	221·1	52·1	20·9
150	330	36·4	216·4	44·8	17·9
160	340	29·6	209·6	36·5	14·6
170	350	18·7	198·7	27·9	10·6
180	360	358·8	178·8	20·4	8·2

According to Prof. Newcomb's elements the values of the argument u at Greenwich mean midnight are—

Nov. 2 ...	... *Deimos* 331°·1	*Phobos*	89°·8
12 ...	... ,, 302·7	,,	217·7
22 ...	... ,, 274·4	,,	345·7

and the diurnal motions of u are 285°·1645 and 1128°·794 for *Deimos* and *Phobos* respectively, giving hourly motions of 11°·882 and 47°·033, whence u for the time of observation may be found. Or if the observer possesses Newcomb's memoir on the satellites he may find it from the table at p. 42. Then with u as the argument the above table gives roughly the angle of position and distance of the satellite, remarking that the former is to be taken in column A or column B, according as the argument is found under A or B. Thus for midnight on November 5 the value of u for *Deimos* is 106°·6, and for *Phobos* 236°·3, whence the positions and distances are: for *Deimos* 51° and 65″, and for *Phobos* 247° and 20″.

THE SATURNIAN SATELLITE, MIMAS.—This faint object was observed by Mr. A. Ainslie Common, of Ealing, with his 3-feet reflector, on the night of September 21, when close up to its conjunction with the following extremity of the ring, which was estimated to take place about 11h. 50m. G.M.T. With the elements which have been previously used in this column the satellite would be up to the ring at 11h. 53m. Such observations as this are of course much more valuable for the correction of elements than estimations of the times of greatest elongations; nevertheless as it is in or near the latter positions that the satellite is most likely to be visible in telescopes of inferior power, we subjoin the times of greatest elongations observable in this country up to the end of the present month:—

EAST.	h. m.	WEST.	h. m.
Oct. 9 ...	12 20	Oct. 16 ...	13 56
10 ...	10 56	17 ...	12 33
11 ...	9 53	18 ...	11 10
12 ...	8 10	19 ...	9 47
13 ...	6 47	20 ...	8 23
		21 ...	7 0
24 ...	14 10	Nov. 2 ...	12 58
25 ...	12 47		
26 ...	11 24		
27 ...	10 0		
28 ...	8 37		
29 ...	7 14		

THE MINOR PLANETS.—Two small planets assumed to be new have been detected by Prof. Peters, of Clinton, N.Y., apparently on September 22 and 26 respectively; the number being thus raised to 203. Prof. Watson, now in direction of the Washburn Observatory, Madison, Wisconsin, has selected the following names for planets discovered by him in 1877: for 174, *Phædra*; for 175, *Andromache*; and for 179, *Clytemnestra*. *Fortuna* will be in opposition on October 23 close up to perihelion, so that the possible brightness, 8·5m., will be at its maximum.

GEOGRAPHICAL NOTES

DR. HOLUB, the eminent African traveller, who is now in England on his way to his native country (Bohemia), intends, it is stated, shortly to undertake another exploring expedition. His return to Europe has for its main object the collection of the necessary funds for the new undertaking. He has formed plans for the formation of an international expedition, which is to be placed under his direction and which is to travel through Africa from Port Elizabeth towards Egypt. The exploring party is to consist of twelve members representing twelve different nations, and the costs of the expedition are to be defrayed by the different governments. The special purpose of the expedition is stated to be the opening of Central Africa towards the south and east and to facilitate the colonisation of the district between the Vaal River and the Zambesi. A correspondent in the *Times* gives the following interesting summary of the remarkable work accomplished by Dr. Holub:—"For seven years Dr. Holub has been exploring the country north and south of the Zambesi, alternating his exploring expeditions with months spent at the Diamond-fields, practising as a medical man to raise the requisite funds for his next journey. In this time the doctor has studied the habits of the Matabele, the Marutsi, Hottentots, Bechuanas, and numerous other tribes, living among them as their guest, and gaining their confidence by curing their sick. In Dr. Holub's third and last journey he has accurately surveyed the country from the Diamond Fields to the Zambesi, and the Zambesi from its junction with the Chobe to the Barotse country. His map of the Zambesi is on a large scale, and shows every island, creek, and rapid. To show the difficulties of this survey, it may be mentioned that, owing to the loss of his *Nautical Almanac*, his sextant was useless, and the bearings had to be taken by compass observations every 300 yards, while the distances, amounting in the various surveys to over 2,000 miles, were determined by *stepping*. That is, the explorer counted every step he took during a twenty-one months' walk. He arrived at Muchela Amsinga tired and unwell, but still full of pluck, and hoping to cross the continent and emerge at Loanda. Then fever came on, and his best canoe, containing all his gunpowder, and, worse than all, his quinine, sank in a rapid. He still pushed on, but at the Nambwe cataract he succumbed, and was carried back insensible by his native servants to lie ill during a period of sixteen months. Even during his illness, however, he was not idle, for being carried about in a litter and directing his men what to pick up, he made magnificent collections of plants and insects, with others of birds, weapons, native drawings, &c. The collection of beetles alone contains no less than 13,000 specimens. Dr. Holub is publishing the account of his journeys in Bohemian, English, German, and French, and is about to read a paper before the Geographical Society of Vienna. He will also read one before the Royal Geographical Society of London when he returns to England at Christmas."

DR. OTTO FINSCH, of Bremen, who is on a tour to Micronesia, by order of the Humboldt Institution of Berlin, arrived at Honolulu on June 17, and first of all proceeded to the island of Maui, where he spent some time in making scientific collections and observations of the Haleakala, the largest volcanic crater on the globe. After his return from Maui he made an excursion to the Bay of Waimanolo in order to visit the ancient Hawaiian

burial-grounds. The traveller has collected some 3,000 zoological and 300 botanical specimens, besides a splendid series of Kanaki skulls; all these collections were packed ready for conveyance to Berlin when he sent the news. On July 27 he left Honolulu for Jaluit (Bonham) in the Marshall group, and has no doubt by this time reached the very district he is specially to investigate. From Jaluit he will proceed to other islands in the neighbourhood.

FROM an early sheet of *Petermann's Mittheilungen* we learn that the Dutch exploring vessel *Willem Barents* arrived at Hammerfest on September 24, having succeeded in reaching Franz Josef Land. The expedition encountered stormy weather in September, and found much ice in the Kara Sea and to the north of Novaya Zemlya. M'Clintock Island, in the south of Franz Josef Land, was surrounded by ice, and on the return journey ice was found east of the 55th degree. They left the *Isbjörn* in Matotschkin Scharr. This *Isbjörn* is the little Norwegian cutter in which Capt. Albert Markham and Sir Henry Gore Booth have been cruising in the Novaya Zemlya seas, and which reached Tromsö on September 22. On June 4 they met with the first ice forty miles from the west coast of Novaya Zemlya, and finding Matotschkin Scharr impassable, they sailed along the west coast of Novaya Zemlya to Cape Nassau, when the *Isbjörn* was stopped by ice. Returning again, the Matotschkin Scharr was passed, but the Kara Sea was full of masses of ice. On their return they fell in with the *Willem Barents*, and Markham decided to press northwards again, and this time succeeded in reaching, on September 6, Cape Mauritius, the north point of the island. Pressing still further northward between Novaya Zemlya and Spitzbergen, the *Isbjörn* reached 78° 24′ N. lat., only about eighty miles from Franz Josef Land.

ADVICES received from St. Lawrence Bay state that the American Polar exploring vessel *Jeannette* arrived there on August 25, and sailed for Cape Serdze Kamen after taking in coal. It is believed that there is a prospect of an open winter in the Arctic Sea this year.

IN his last official report from Copenhagen, Her Majesty's Consul states that the Danish war vessel *Fylla*, which during the fishing season is stationed off the coast of Iceland, has made some deep-sea soundings and measurements, and brought home many interesting particulars respecting the currents and temperature of the Polar Sea. On one of these expeditions she penetrated so far north in the ice as to find cold water (*i.e.*, under freezing point) from two fathoms below the surface to the bottom, by which was proved the presence of an ice-cold polar current; the existence of this had not been previously ascertained, owing to the impenetrable ice-masses. The soundings were taken both on the north coast and in Denmark Sound. The extent of the polar ice is varying and changeable, for at the time the *Fylla* was able to penetrate many miles direct north in open water from North Cape, Iceland, a mail steamer could not enter Ofjord owing to the ice, and a French war steamer was stopped by ice about five miles from the coast between these points. During the whole time the *Fylla* met with very much drift-wood, which increased in quantity as she advanced northwards. The foregoing notes are of considerable interest when considered in connection with portions of Mr. G. F. Rodwell's letter from Iceland, in last number.

THE October number of the Geographical Society's monthly periodical opens with a long paper by Capt. G. Martin, on the information obtained in regard to the Kurram Valley during the survey operations of the Afghan expedition. At the present juncture, this paper will, no doubt, be read with much interest, but, though the author states that "he has endeavoured to be as brief as possible," we incline to the opinion that his observations might with advantage have been very considerably curtailed. In the geographical notes we find news respecting the Rev. T. J. Comber's expedition to the Congo, Danish discovery on the coast of Greenland, and the Dutch Arctic expedition. Some further particulars in regard to Mr. Keith Johnston's sad death and the East African expedition are also included under this head.

THE Marine Survey Department, Calcutta, has lately issued a hydrographic notice which contains some information in regard to Pemba Island and the adjacent coast of East Africa. The island is thirty-eight miles long and about thirteen miles wide, including the islands on its western side, which protect the numerous harbours there. The east coast is rocky and straight, with only a few slight indentations. The height of Pemba Island does not exceed 300 feet, and the surface is broken into ridges and valleys, covered with luxuriant vegetation. The soil is rich, the chief produce being cloves, most of the groves of which are situated on the west side of the island. All tropical cereals and edible roots flourish, and on the eastern side the Wapembe, or descendants of the aborigines, keep large herds of cattle. Cocoa-nuts abounded, but no oil-making is carried on, most of the nuts being consumed locally and the remainder sent to Zanzibar to be converted into oil. The greater part of Pemba Island is under cultivation, or is grazing-land, but a little forest exists here and there. The island is governed by a Wali, appointed by the Sultan of Zanzibar, and residing at Chaki Chaki, the only place of any importance.

NOTES

WE learn that Dr. Thwaites, F.R.S., C.M.G., has resigned the directorship of the Royal Botanic Gardens, Peradeniya, Ceylon, to which he was appointed in 1849. This step has been for some time contemplated by Dr. Thwaites, on whose somewhat feeble health the charge of the botanical interests of the island, especially in relation to the coffee-leaf disease and the introduction of new kinds of cultivation, has of late pressed heavily.

IN a recent paper to *La Nature* on the employment of the hydro-electric batteries and Reynier lamps for domestic lighting, M. Reynier comes to the following conclusions:—The most powerful battery is the Bunsen, Ruhmkorff model; but it is inconvenient and deleterious, and expensive. The most economical and constant battery is the Thomson; but it is costly and cumbrous. The most convenient battery would be a well-arranged rotatory one; but the price would be high (200 fr. at least) and the daily cost enormous. A battery as powerful as the Bunsen, as economical as the Thomson, and as convenient as a well-arranged rotatory one, would still be far from suitable for electric lighting. Hence it is not at present among hydro-electric batteries that we have to look for the solution of a domestic motor applicable to the present electric lamps.

AS will be seen from our advertising columns, the Council of the Entomological Society of London is authorised by Lord Walsingham and other gentlemen interested in the diseases of our native game birds to offer to public competition the following prizes:—50*l.* for the best and most complete life-history of *Sclerostoma syngamus*, Dies., supposed to produce the so-called "gapes" in poultry, game, and other birds; 50*l.* for the best and most complete life-history of *Strongilus pergracilis*, Cob., supposed to cause the grouse disease. No life-history will be considered satisfactory unless the different stages of development are observed and recorded. The competition is open to naturalists of all nationalities, and the same observer may compete for both prizes. Essays in English, French, or German, to be sent in on or before October 15, 1882, addressed to the

Secretary of the Society, 11, Chandos Street, Cavendish Square, W.

THE death is announced of Prof. Mohr, of Bonn University, at the age of seventy-two. Mohr, like his father, was originally an apothecary at Coblenz. In 1864 he was attached to Bonn University, and some of his works on chemistry, geology, and physics have been translated into foreign languages. His activity was inexhaustible.

AN experiment was tried on October 4 by M. Menier, in a large park belonging to him at Noyelles, on the banks of the Marne, about 50 kilometres from Paris, on the Eastern Railway. A part of the water power which he uses for his workshop operates on eight ordinary Gramme machines producing the current for the Serrin regulators or Jablochkoff candles. The current of two of these machines was sent into the park at a distance of 700 metres, where two others had been arranged on a truck and connected with a plough by a dragging rope. A number of furrows were then traced with this simple apparatus, and have been found equal to the work of four oxen. The experiment has been found so successful that M. Menier intends devoting a water-power of thirty horses to agricultural work round his workshop. He intends using water-pipes for placing his insulated copper wires, and expects to conduct his power to 5 kilometres from his mill in every direction, so to perform various agricultural operations on a surface of more than ten square miles.

THREE different telephonic companies are competing in Paris, viz., the Gower (magnetical), Bell, and Edison, the two latter working with the microphone. It is said that the Bell and Edison Companies will enter into a working arrangement, or a fusion.

THE city of Lille, in French Flanders, sends every year to England the best English scholars of the Municipal School. This year the journey made at the expense of the city has taken unprecedented extension. The number of travelling pupils was twenty-three, and the excursion occupied a fortnight, during which not only London, but Edinburgh, Dundee, Glasgow, Newcastle, Durham, and York were visited.

THE tramway from Naples Observatory to the foot of the cone of Mount Vesuvius is nearly completed, and will be opened early next year. A steam-engine at the summit will draw the trams up by a windlass on Spielg's system.

WE understand that by the retirement of Dr. Gilchrist from the charge of the Crichton Asylum at Dumfries, a very important and valuable appointment is now open to the psychological branch of the medical profession.

A FACULTY of Medicine has been created at Bordeaux. M. Ferry, the Minister of Public Instruction, will be present at the ceremony of laying the first stone.

THE French Minister of War has published a regulation for organising optical telegraphy in time of peace. The several places on the French frontier are to be connected by posts; apparatus are to be manœuvred by persons trained and keeping records of communications sent or received. This new service is to be placed nnder the supervision of the Director of Aërial Communications, who already has command of the balloonists and the colombophiles for carrier-pigeons.

THE *Times* Geneva correspondent states that a fisherman has found a very remarkable weapon near the lake-dwelling of Locras, in the Lake of Brienz. It is a double battle-axe of pure copper, forty-two centimetres long, and weighing three kilogrammes. Massive and heavy in the middle, it broadens out gradually into two cutting edges, each having a width of twelve centimetres. It has been added to the collection of Dr. Gross, at Neuveville. Several similar weapons have been found in Denmark; but, so far as is known, this is the first of the kind discovered in Switzerland. The lake-dwelling of Locras is assigned by archæologists to the age of stone.

AT Trier (Treves) a fresh discovery of colossal remains of Roman structures has recently been made. They consist mainly of a large wall, 1·88 metres thick, with two other ones running parallel to it and only 90 centimetres apart. Between the latter two, at a depth of 8 metres below the present surface of the ground, there is a vaulted canal, and a little further on an enormous cellar vault. The foundations of the two parallel walls have in some parts not been reached at a depth of 9 metres. Archæologists are at present at a loss to know what may originally have been the nature of the structure, as nothing at all resembling it has ever been discovered.

WE have received from the Dundee Naturalists' Society very satisfactory reports of the work done during the sessions 1877–8–9.

IN a recent communication to the Vienna Academy, on the cause of excitation of electricity in contact of heterogenous metals, Prof. Exner offers proof that the electromotive force is always in direct relation to the heat of combustion of the metals in question, provided they are in air. Such proof is quantitatively furnished for the combinations of Zn, Cu, Fe, and Ag, with Pt. Further it is shown that the so-called contact-force of two metals changes, whenever these are no longer in air, but in some gas acting in a different way on them chemically. Numerical proof of this is given in the case of Ag, according as this metal is in air or in an atmosphere of chlorine. Since the numerical values obtained in this research, for the contact-force, as also the few older determinations are in full harmony with the chemical theory of this mode of electric excitation, and the experiments are contrary to the voltaic theory, the author considers further adherence to the latter impossible.

THE radicles of seeds lying on the surface of the ground penetrate into the ground only under certain conditions. According to recent observations by Dr. Richter, of Vienna, these are of the following nature:—1. The penetration takes place only when the temperature exceeds a certain minimum above the lower zero of germination, depending on the species of the plant. 2. This minimum is much lower, for one and the same plant species, if the seedling is exposed to light, than if it is kept in darkness, the reason being that in the former case a transformation of light into heat occurs (as shown by experiments of cultivation at temperatures above the optimum of germinating temperature of particular plants). 3. A pressure of the roots on the ground, whether through formation of root-hairs, or from external causes, favours the penetration of the roots. 4. The nature of the ground affects the penetration of roots, only in that the latter occurs more easily the less resistance the ground presents to the roots. 5. Geotropism is naturally concerned most largely in the penetration of the roots. The light affects it in so far as by production of heat, it favours the growth generally, and therewith the geotropic downward-bending. On the other hand, negative heliotropism is (contrary to expectation) not concerned in penetration of illuminted roots into the ground.

THE Rouen journals report an invasion of swarms of bees in several houses of the town. In a confectioner's establishment legions of these bees took possession, making it impossible for the workmen to continue their occupations. Nearly every inmate of the place was stung, and one person was maltreated so severely that medical aid had to be called in. An attempt was made to get rid of these importunate guests by burning sulphur to asphyxiate them, but the bees took refuge in the upper storeys

and when the smoke had abated, they descended again, and were as troublesome as before.

THE general meeting of German Archæologists and Historians took place at Landshut (Bavaria) on September 14 last, and was well attended by members from all parts of Germany. Prof. Ohlenschlager, of Munich, delivered the first lecture "On the Survey made of the so-called Devil's Wall in Bavaria." Great interest was evinced in a paper read by Prof. Rhiza, of Vienna, "On the Marks made by Masons and Stone Workers at different Periods and in Different Districts."

KARL VON SCHERZER, Austrian Consul-General at Leipzig, has been nominated honorary member of the Senkenberg Natural History Society at Frankfort-on-the-Main.

THE "Oberlausitzische" Scientific Society at Görlitz (Silesia) celebrated the centenary of its foundation on October 8. At the same time the 153rd General Meeting of the Society took place.

AT the Baden-Baden meeting of the International Society for the Prevention of the Pollution of Rivers, the Soil, and the Atmosphere, which took place on September 16 last, the three principal addresses were by Professors Reclam, of Leipzig, Vogt, of Berne, and Ewich, of Cologne. Prof. Reclam spoke on canalisation and the pollution of rivers in Germany and England; Dr. Vogt on the influence of the sun upon the walls of houses; and Dr. Ewich on the origin of springs and wells.

IT may interest our readers to know the elevations which at present are reached by lines of railway in different parts of the world. The Apennine Railway reaches its highest point at an elevation of 617 metres above sea-level; the Black Forest Railway ascends to 850 metres, the Semmering line to 890, the Caucasus line to 975 metres. The St. Gothard tunnel is 1,154 metres above sea-level; the railway across the Brenner reaches 1,367 metres; the Mont Cenis Railway ascends to 1,338 metres, the North-Pacific line to 1,652, the Central-Pacific to 2,140, and the Union-Pacific to 2,513 metres. The highest of all is the line across the Andes, which reaches an elevation of 4,769 metres.

DR. BRAUNS, of Halle, has been appointed Professor of Mineralogy and Palæontology at the Japanese University of Tokio. It is stated that some twenty-five amongst the teachers at this University are Germans.

AT Carlsruhe a meeting of a large number of agricultural chemists from all parts of Europe took place on September 16 and 17 last.

WE have a satisfactory report of the Queenwood Mutual Improvement Society for the end of the summer term 1879. A good deal of practical natural history work seems to be done by the members, and the report contains an interesting account of three carrion crows that were tamed by some of the boys, remaining about the premises, "showing themselves as familiar and companionable as the most faithful dogs."

ON Thursday last the Chester Society of Natural Science held a very successful *conversazione*. The Kingsley Memorial Medal, established in memory of the Society's first president, was awarded to Sir P. de M. Grey Egerton, for "having contributed materially to the promotion and advancement of natural science," and the Kingsley Memorial Prize to Mr. G. Shrubsole, jun., for his collection of fossils illustrating the carboniferous limestone, millstone grit, and coal measures.

MR. F. H. BROOK, of Walworth, has sent us a useful Price List of Electrical Apparatus, containing upwards of 450 items.

THE annual exhibition of the Photographic Society was opened on Monday, at the Gallery, 5, Pall Mall, East.

WE very much regret to learn that the publishers of the *American Chemist* have been obliged to discontinue the publication of that valuable journal.

A DISCOVERY calculated to throw some light on prehistoric man has recently been made by the excavation on the banks of Lake Ladoga of a human skeleton belonging to the stone period, along with many well-preserved skulls and bones, remains of plants and animals, and instruments of stone and bone. These remains were found at a depth of from about 12 to 20 feet below the surface of the lake.

TWO shocks of an earthquake were felt at Annecy, Savoy, at 4 A.M. on Saturday, both accompanied by a rumbling noise.

MR. STANFORD has published a useful Section of British Strata, showing the order of superposition and maximum thickness of strata in the British Islands, by Mr. James B. Jordan. The section was originally prepared as an Index of Colours to Stanford's Geological Map of the British Islands, edited by Prof. A. C. Ramsay, by whom it has been revised and corrected.

THE Museum of the French Colonies at Paris, which, as we stated, has received a sensible augmentation by the addition of a large part of the Algerian collections, is undergoing a total reorganisation. A new director and sub-director have been appointed.

THE Peking correspondent of the *North China Herald* learn that the engagement of the geologist and mining expert, Mr. Arnold Hague, by Li Hungchang, has terminated, owing to the obstructions constantly put forward by the Central Government. A few metal-bearing localities have been examined, but noting definite has been learned of the resources of the province of Chihli. At the date of the letter referred to Mr. Hague was at Peking, on his way to Mongolia, where he intends to make some excursions, partly with a view to scientific investigations. He will afterwards return to the United States to take up an official appointment in connection with certain new systematic surveys which it has been determined to make there.

THE Government of Victoria have just appointed a board to advise them as to the best mode in which assistance can be given to further the development of the auriferous and mineral resources of the colony.

NO. 3 of "Dimmock's Special Bibliography" (Cambridge, U.S.) consists of a full list of the writings of Samuel Hubbard Scudder, which ought to be specially valuable to entomologists.

WE have on our table the following works:—"The Spiders of Dorset," Rev. O. Pickard Cambridge; "Chemical and Geological Essays," by T. Sterry Hunt (Trübner); "Deaths in Childbed," Dr. Æneas Munro (Smith, Elder, and Co.); "The Silk Goods of America," W. C. Wyckoff; "Structural Botany," Dr. Asa Gray (Trübner); "Luxurious Bathing," A. W. Tuer (Field and Tuer); "Phrenology Vindicated," A. L. Vago (Simpkins); "On the Diffusion of Liquids," J. H. Long (H. Laupp); "Reform Essays on Incentive Religion and Warfare;" "Farming for Pleasure and Profit" (Poultry Keeping), Arthur Roland (Chapman and Hall); "Manual of Practical Anatomy," J. Cossar-Ewart (Smith, Elder, and Co.); "Rays from the Realms of Nature," Rev. James Neill (Cassell); "Jack's Education; or, How He Learnt Farming," Prof. Henry Tanner (Chapman and Hall); "Vocal Physiology and Hygiene," Gordon Holmes (Churchill); "Fauna der Gaskohle und der Kalksteine der Perm Formation Böhmens," Dr. Ant. Fritsch.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Sir Arthur Scott, Bart.; a White-

cheeked Capuchin (*Cebus lunatus*) from South America, presented by Mr. Adrian Hope, F.Z.S.; an American Red Fox (*Canis fulvus*), a Rough-legged Buzzard (*Archibuteo lagopus*) from Labrador, presented by Lord Hobart; three Vulturine Guinea Fowls (*Numida vulturina*), a Crested Guinea Fowl (*Numida cristata*) from East Africa, presented by Vice-Admiral John Corbett, C.B.; two Malabar Mynahs (*Sturnia malabarica*) from Hindostan, a Chinese Mynah (*Acridotheres cristatellus*) from China, a Waxwing (*Ampelis garrulus*), European, presented by Mr. A. F. Weiner, F.Z.S.; five Fat Dormice (*Myoxus glis*), European, presented by Mr. Edwin Liot; seven Green Tree Frogs (*Hyla arborea*), a Green Lizard (*Lacerta viridis*), three Spotted Salamanders (*Salamandra maculosa*), European, presented by the Rev. S. R. Wilkinson, F.Z.S.; an Anaconda (*Eunectes murinus*) from South America, presented by Capt. E. Ball; an Elliot's Guinea Fowl (*Numida ellioti*), a Vulturine Guinea Fowl (*Numida vulturina*), three Mitred Guinea Fowl (*Numida mitrata*) from East Africa, a Booted Eagle (*Nisaetus pennatus*), European, purchased.

ON THE GRADUAL CONVERSION OF THE BAND SPECTRUM OF NITROGEN INTO A LINE SPECTRUM

PROF. WÜLLNER, of Aachen, has recently published a treatise on the two different views which are held by physicists with regard to the various spectra presented by gases which are rendered incandescent by means of induction sparks. One of these views was first stated by Ångström, who thought that for a certain gas only one spectrum was possible, and that this spectrum consisted of lines only. All band spectra which occasionally appeared when gases were examined in the way mentioned, he ascribed to impurities. The band-spectrum of nitrogen, according to his idea, belonged to oxides of that element. He believed that as long as the current passed through the gas without giving a spark, the oxide was rendered incandescent as such, without decomposition, and that the spark decomposed the oxide, and that only then the nitrogen could give its own line-spectrum. Later on Ångström modified this view, and admitted that an elementary substance might give several spectra when rendered incandescent in the gaseous state, but he still held that in this case the element in question entered into isomeric compounds with itself, and that the different spectra belonged to different isomeric compounds. Mr. Lockyer afterwards defined this view more clearly, stating his opinion that the line-spectrum is produced by simple atoms, and the continuous or channelled-space spectra by conglomerations of molecules.

Prof. Wüllner, however, does not consider this hypothesis necessary for the explanation of the different spectra of elements, but holds that they may be explained by Kirchhoff's maxim. Prof. Zöllner has pointed out that the light emitted by a radiating layer of gas must essentially depend on the thickness and density of the layer. Prof. Wüllner, therefore, after having first confirmed the fact that the line-spectrum of elementary gases only appears with the real electric spark, the band-spectrum, however, when in the gas the electro-positive brush and glow appears, ascribes the different spectra to the differences in the radiating layers of gas. He believes that in the spark only the molecules struck by the spark are glowing, therefore almost only a linear row of molecules; thus in the spectrum only the absolute maxima of the emission power, which correspond to the temperature of the spark, become apparent. If, however, in the positive brush light the whole quantity of gas contained in the spectral tube is rendered incandescent, then it is always a relatively thick layer which emits light; in the spectrum all those kinds of light must show themselves for which at the respective temperature the power of emission is above zero. But since the incandescent gas is always of relatively small density, all the differences in the emission power of the various kinds of light must become apparent in the spectrum, and thus the latter must be richly varied or shaded; this is indeed the case in the band-spectra of gases. Prof. Wüllner adduces the spectra of iodine vapour as proofs of the correctness of his view. When rendered incandescent by means of a hydrogen flame, iodine vapour gives the negative absorption spectrum, which is of the same character as the band-spectra of gases; if rendered incandescent through the spark, the glowing iodine molecules give a bright line-spectrum.

The band-spectrum of nitrogen shows, that this element at the temperatures obtained by electric discharges possesses quite as great a power of absorption as that of iodine vapour at low temperatures, because the band-spectrum of nitrogen is essentially of the same character as that of iodine vapour, however different it may be from it in detail. Of all other gases, nitrogen must therefore be particularly adapted for showing, through the examination of the light it emits, the dependence of spectral phenomena from the thickness and density of the radiating layer of gas, and thus for furnishing the proof that there is no constant spectrum of nitrogen, but that a certain spectrum exists only at a certain temperature and density of the gas. This indeed is the question upon which turns the difference of opinions of Ångström and Lockyer on the one hand and of Wüllner and Zöllner on the other; the former ascribing the different spectra to chemical differences in the molecular conditions of the gas, the latter merely to differences of temperature, density, and thickness of the radiating layer.

In a former treatise on the nitrogen spectrum, Prof. Wüllner, without having recognised the importance of the density of the radiating layer with regard to the light emitted, pointed out that when the pressure in a nitrogen tube is diminished to such an extent that it ceases to be measurable, the brightness of the spectrum decreases, and in such a manner that the darker parts first fade away, so that at last only the brightest parts remain. He added that in this way the nitrogen spectrum in its character approaches a spectrum of the second order (the name given to line spectra by Plücker) without, however, changing to the nitrogen spectrum of the second order, since no new bright lines appear. At that time, however, Prof. Wüllner did not continue his researches in that direction, and in particular he did not examine whether the bright parts remaining do indeed correspond to the maxima of the complete band spectrum, because the spectra he obtained at those pressures were too weak to allow of measurements being made with the instruments then at his disposal. Lately, however, the Professor has minutely examined the nitrogen spectrum in this sense, employing a simple contrivance for rendering the spectra bright enough for measurements, even at the lowest pressures. This consisted in the employment of spectral tubes of very narrow calibre (about 2 mm. in diameter).

It must be remembered here that the temperature of the gas, which is caused by the induction current, rises with decreasing diameter of the tube. (If, however, the tubes were taken too narrow, the current at once broke them.)

Since the resistance in the tube rises as the density of the gas decreases, at least from a certain point of low pressure downwards, the temperature rises as well. If the rise in the temperature was sufficiently great, the experiment described by Prof. Wüllner necessarily decided the only hypothetical part in his conception of spectral phenomena, viz., whether with a rising temperature the absorption power for the various kinds of light grows in a similar manner or not. If it does grow simultaneously with the temperature, then the relative maxima of intensity of light which the complete band spectrum shows must always remain the same; the bright parts remaining at the lowest density must correspond to the maxima of the band-spectrum. If the contrary is the case, and this is what Prof. Wüllner assumes, then dark parts in the band-spectrum may become the brighter ones as the density decreases, and the bright parts remaining at the lowest pressure may be situated at places in the spectrum differing widely from the maxima of the band-spectrum. The first part of the experiment therefore consisted in an exact determination of the relative maxima in the band-spectrum of nitrogen for the sake of comparison. This is minutely described in Prof. Wüllner's paper. The final results of the observations were in complete accordance with the Professor's conception of the spectral phenomena. There is indeed no definite nitrogen spectrum when in layers of sufficient thinness the density of the gas is reduced below a certain limit. The band spectrum changes step by step into a line-spectrum; this, however, is not identical with the line-spectrum produced by the spark, but has only a certain number of lines in common with it. In this gradual change it is easy to follow the displacement of the maxima of brightness which takes place little by little as the temperature rises, and is quite conspicuous in several places; this displacement is the very cause why in this line-spectrum the lines in places differ widely in their situation from the maxima of brightness of the band spectrum.

Prof. Wüllner then gives an exact description of that part of

the complete band-spectrum (at a pressure of about 5–10 mm.) in which the variability of the spectrum is most conspicuous, viz., in the green and blue (from wave-lengths 562 to 449); this is followed by an account of the gradual changes taking place in two different places when the density of the gas is decreased. It would lead us too far to enter into the details here; suffice it to say that the richly-shaded band-spectrum changes quite gradually into a line-spectrum, and that most of the lines of the latter are in places which show no maximum of brightness in the band-spectrum. It results from these observations that the positions of the maxima of emission-power do not remain at all the same in all temperatures, but that in consequence of the changes of temperature accompanying the decrease of pressure they may be considerably displaced.

Prof. Wüllner gives the reasons why the wider tubes are unsuitable for the gradual conversion of band-spectrum into line-spectrum, and eventually describes the differences between the line-spectrum obtained from the band-spectrum in the manner described, and the line-spectrum obtained by the spark. Upon comparison of those regions in the two spectra which were examined more closely (beginning at wave-length 572), it was found that in the spark-spectrum there are about forty lines in this region. Of these eight correspond very closely to maxima or lines in the fully developed band-spectrum. The number of coincidences with the lines of the low density line spectrum is, however, much greater; perfect, or very nearly perfect coincidence occurs in nineteen lines, *i.e.*, about half the number, and amongst these there are four which are the same in the three different forms of the nitrogen spectrum. The brightest lines of both line-spectra are, indeed, perfectly coincident. These are the yellowish-green lines 568,4 and 567,1, the green lines 500·7 and 500·4 (which result from the green-channelling described in detail) and the blue line 463·2 (developed from the blue channelling). Another interesting similarity exists between the two line-spectra, however differently about half of their lines may be situated.

Plücker and Hittorf distinguish five principal groups in the line-spectrum of nitrogen, between which there are other single lines. Of these five groups Nos. II. to V. belong to the region specially studied by Prof. Wüllner. These groups are:—

Group II. between wave-lengths 577—567
Group III. „ „ 555—545

Between groups III. and IV. there are first three lines: 535·6, 534·4, and 532·3; and then two lines: 518·1, and 517·6.

Group IV. between wave-lengths 508—499

Between groups IV. and V. there are first four lines: from 489·6, to 484·8, and further on three lines: 480·5, 479·0, and 478·1.

Group V. between wave-lengths 464·5—460·2.

All these groups are situated in such parts of the spectrum where also the line-spectrum developed from the band-spectrum is very rich in lines. It follows, therefore, that the spark-line spectrum is developed, on the whole, in such places which show the greatest variability, even in a gradual decrease of the density of the gas, and which are richest in lines in the low-density line-spectrum.

Prof. Wüllner recapitulates his interesting treatise in the following manner:—The course of spectral phenomena of nitrogen, which takes place when the gas is gradually reduced in density in tubes of sufficiently small diameter, shows exactly those changes which may be deduced from Kirchhoff's maxim, that the smaller the number of incandescent molecules, the more the spectrum contracts into a number of bright lines.

At the same time it may be directly observed when the density of the gas is decreasing, how, in consequence of the temperature rising through increasing resistance in the tube, the maxima of brightness change their position, how the maxima of the fully-developed band-spectrum fade away, and how the lines become prominent in places which are either secondary or tertiary maxima or uniformly illuminated regions in channelled spaces. Now, if we further consider that the lines of the spark-spectrum, compared to those of the former line-spectrum, are not more considerably displaced than the latter are with regard to the maxima of the band-spectrum, then we can hardly doubt that in the different forms of the nitrogen-spectrum we see nothing else but the light emitted each time in accordance with the different temperature, density, and thickness of the radiating layer of gas, and that a new hypothesis for the explanation of these spectral phenomena is unnecessary and superfluous.

A HISTORICAL SKETCH OF THE VARIOUS VAPOUR-DENSITY METHODS[1]

ALTHOUGH Southern,[2] in 1803, made some very careful experiments to determine how much water was required to furnish 1 cubic foot of steam at various pressures, still the foundation of vapour-density methods was laid by Gay-Lussac.

He, in 1811,[3] started on the correct basis of accurate work when he heated a weighed quantity of substance over mercury in a graduated vessel. Muncke, in 1816,[4] heated the substances *in vacuo* in elliptic glass balloons of 155 c. i. capacity, closed with a stop-cock and with thermometer and syphon barometer suspended inside. In 1822[5] Cagniard de la Tour determined the combined effects of heat and pressure on certain volatile liquids, but as his results were on the question of maximum vapour-density, they hardly enter the domain of the present sketch. In the same year Despretz,[6] who gave no drawing, and only a very imperfect description of his apparatus, published a method in which he used a 9-litre exhausted globe, and made his determinations at atmospheric temperatures, employing only a small quantity of substance.

In 1826 Dumas,[7] wishing to operate on substances which attack mercury, worked out and published his well-known method in which the volume is definite, but the amount of substance required to fill that volume with vapour has to be subsequently determined.

In 1833[8] Mitscherlich proposed using tubes, sealed at one end and drawn to a neck at the other, instead of bulbs, and gave details and drawings of the apparatus for heating them; but Dumas, two years later, objected to the proposed alteration in his method, for he wrote:—

"We must then leave to this operation all its simplicity to make it essentially practical, and such, in fact, that with an ordinary cast-iron pot and some pieces of iron wire we can perform it. This is what I have done from the first, and what I persist in doing, my aim never having been to make a piece of apparatus for the cupboard of the physicist, but to give chemists a simple and eminently practical and yet exact process. After all *they* are the only ones to be considered."[9]

Deville and Troost,[10] however, in 1860, in referring to that same apparatus, called it "La méthode si élégante de M. Mitscherlich."

Bineau, in 1838,[11] published an elaborate paper, but unfortunately without any drawings, for when we read the following paragraph, "The bodies on which I have worked have been volatilised sometimes by the aid of heat by following the process of Dumas or that of Gay-Lussac, sometimes without elevation of temperature by working in the barometric vacuum or by allowing the vaporisation to take place in dry air or hydrogen," we cannot but feel that an enormous amount of valuable work has been lost for want of details. In 1844 we find Cahours,[12] as well as Bineau,[13] at work at the same subject. In 1846 the latter[14] repeated the experiments of Despretz with slight modifications, but called attention to the fact that the result was seriously affected by very small errors in reading off the mercurial column.

In 1849 Regnault[15] described an apparatus very similar to that of Mitscherlich, but arranged the tube supports so that the two could be withdrawn simultaneously; he also dispensed with sealing the tube containing air by providing it with a stop-cock. Bineau,[16] in 1859, in order to operate at high temperatures, coated the glass tubes with clay and heated them in a sand-bath.

Regnault,[17] in 1861, to obtain the same result, used iron tubes, and to ensure uniformity of temperature, heated them in a cast-iron tube which was made to revolve over gas-burners. The tube which served as air-thermometer was furnished with a stop-cock, but that containing the substance only terminated in a small aperture, and was not closed, as a snfficient quantity was

[1] Paper read at the British Association by Jas. T. Brown, F.C.S.
[2] *Phil. Mag.*, 30, 113 (1847).
[3] *Ann. de Chim.*, 80, 218 (1811); *Gilbert Annal.*, 45, 332 (1813).
[4] *Schweigger's Journ. Chem. Phys.*, 21, 1 (1818).
[5] *Ann. Chim. Phys.*, 21, 127 and 178 (1822); 22, 410 (1823).
[6] *Ibid.*, 21, 143 (1822); *Quart. Journ. Sci.*, 15, 297 (1823).
[7] *Ann. Chim. Phys.*, 33, 337. [8] *Ibid.*, 55, 5–41 (1833).
[9] "Traité de Chimie," 5. 44.
[10] *Ann. Chim. Phys.* [3], 58, 259. [11] *Ibid.*, 68, 416.
[12] *Compt. Rend.*, 19, 771 (1844); *Pogg. Annal.*, 63, 593 (1844).
[13] *Compt. Rend.*, 19, 768 (1844); *Liebig's Ann.*, 65, 424 (1845).
[14] *Compt. Rend.*, 23, 414 (1846); *Ann. Chim. Phys.*, 18, 226 (1846); *Ann. Chem. Pharm.*, 60, 158 (1846). [15] "Cours de Chimie," 4, 66 (1849).
[16] *Compt. Rend.*, 49, 799 (1859).
[17] *Ann. Chim. Phys.* [3], 63, 54 (1861).

introduced before the heating, to allow it to be taken for granted that during the experiment there was no residual air.[1] Another method of Regnault's was to have two iron bottles of as nearly as possible the same size cast in one piece. In one of these the substance was placed, and in the other a small quantity of mercury. The necks were then partially closed by loose stoppers, and the system was heated in a muffle. After heating it was withdrawn and allowed to cool, and the quantities remaining in the bottles were determined by suitable means.

Grabowski,[2] in 1866, did much to shorten the Dumas calculation, while he allowed the method to retain all its accuracy and simplicity when he proposed to heat a bulb containing air in the same bath and of the same size as that containing the substance. After being heated the two bulbs were then sealed at the same temperature. Bunsen,[3] in 1867, employed an air-bath similar in principle to those of Mitscherlich and Regnault, but heated it by a very elaborate arrangement of gas-burners. He also simplified the calculation by taking care that *all* the tubes were of *exactly* the same weight and same size. He did not seal the tubes, but closed them by glass caps lined with india-rubber and fitted with glass plugs. Dumas,[4] in cases where the vapour rendered the outlet difficult to seal, used globes fitted with ground stoppers.

For the Dumas process at high temperatures Deville and Troost,[5] in 1857-9, recommended heating the bulb in a specially constructed furnace in the vapours of substances having high but definite boiling-points, such as mercury, sulphur, zinc, or cadmium (in 1873 Dewar and Dittmar[6] used a bath of boiling zinc in experiments on the vapour-density of potassium); for temperatures above the boiling-point of sulphur they used porcelain globes. For[7] temperatures up to that point the smaller and more compact apparatus devised by Greville Williams answers admirably.

Roscoe,[8] last year, in determining the vapour densities of the chloride of lead and thallium, used porcelain globes of 300 c.c. capacity, heated in a muffle, but determined the temperature by the method of specific heat, a large piece of platinum being employed for the purpose, and checked the result by the simultaneous determination of the vapour-density of mercury.

For[9] working at a reduced pressure Regnault proposed partially exhausting the bulb by means of an air-pump during the experiment; when the desired temperature was reached, it was sealed off at a point where the neck had been narrowed to a convenient size. In 1876 Habermann[10] gave a complete diagram of the apparatus, replacing the air-pump by a Bunsen-pump; but although he made no alteration in the method, still it was referred to by Sommaruga[11] as Habermann's.

The readiest method of determining the *residual* air is that of Greville Williams,[12] viz., to measure by means of a burette the quantity of mercury which is required to displace it. Deville and Troost[13] recommended weighing the mercury required.

Various experiments had been performed on vapours mixed with air, but the main point in Playfair and Wanklyn's[14] method (1861) consisted in stopping the supply of vapour before the bath in which the bulb was being heated had attained its maximum temperature.

Natanson,[15] in 1855, in order to use the Gay-Lussac method up to a temperature of 300°, heated the upper part of the tube by means of charcoal in a cylindrical furnace, and determined the temperature by thermometers suspended in the air-space between the graduated tube and the inner tube of the heating apparatus. In correcting for the tension of mercury-vapour he used Avogadro's tables.

Greville Williams[16] in 1857, wishing to make some determinations at varying pressures, devised the following method:—The graduated tube is, after it has been filled and the bulb has been inserted, screwed by means of a nipple cemented to the bottom into an orifice in the top of a small metallic cistern into a second orifice in which a long open glass tube is fitted. Into this tube mercury is poured until the required pressure is obtained. To reduce the pressure the excess of mercury is allowed to escape by a tap in the side of the cistern. The whole is heated in a water- or oil-bath.

In Regnault's[1] apparatus for the same purpose the two tubes are fastened to the bottom of the water-bath, and are connected by a T-piece, which is closed by a 3-way cock of special construction.

For determinations[2] up to 150° Greville Williams's compact modification consists in replacing the large vessel of mercury and the open glass cylinder by a cylinder closed and rounded at the lower extremity so as to resemble a large test-tube. This is then filled to a depth of 50–60 mm. with mercury, and above that with water or oil to a convenient height. The graduated tube is filled and the bulb inserted over the mercurial trough; it is then immersed in the large tube by means of a rod having at the end a small cup containing mercury. The large tube may be supported on wire gauze and heated by a Bunsen burner, or may be placed in a shallow oil-bath.

Schiffin,[3] in 1862, proposed steadying and manipulating the graduated tube by means of a loaded handle, which was secured to its upper extremity by spring clips.

Grabowski,[4] in 1866, replaced the charcoal furnace of Natanson by a very much neater air-bath heated by gas, but the chief merit in his method is that a tube containing air is heated by the side of that containing the substance. As soon as the substance is all converted into vapour, air is passed up into the second tube until it occupies as nearly as possible the same volume as the vapour. After the operation the air is measured at atmospheric pressure and temperature.

Croullebois,[5] in 1874, reverted to Bineau's method of using a large globe with a long tube, but took the precaution to heat the upper portion in a water-bath. Deville,[6] however, criticised his method rather severely, and pointed out that it was an unwieldy apparatus to manipulate.

In 1868, Hofmann,[7] in modifying the Gay-Lussac method, while he adopted the long tube which had been previously used by Bineau, Playfair, and Wanklyn, and Grabowski, introduced such an important alteration into the apparatus that it is not spoken of as his modification, but as his method. Instead of heating the substance-tube by a water-, oil-, or air-bath, he simply inclosed it in a slightly larger mantle tube, and passed the vapour of a liquid of definite boiling-point through the intervening space, selecting the liquid according to the temperature required. By this means he not only rendered the apparatus much more compact, but he maintained a steady temperature with the greatest ease. Wichelhaus,[8] in 1870, anxious to avoid the uncertainty introduced by the doubt as to the temperature of the column of mercury between the bottom of the outer tube, and the trough, dispensed with the latter by fixing to the lower extremity of the substance-tube an inverted syphon containing mercury. Then by lengthening and suitably enlarging the lower extremity of the outer tube, the whole of the inner one can be surrounded by vapour.

Grabowski,[9] in 1875, in order to obtain a high temperature, employed the vapour of naphthalene as the heating medium in using Hofmann's apparatus; but Engler,[10] in the following year, finding that the stoppage of the tubes from the solidification of the condensed hydrocarbon was troublesome, proposed to obviate the difficulty in the following manner:—He fixed to the lower end of the outer tube a metal socket provided with a short side-tube similar to those used for heating funnels. Then, by boiling the heating medium in this tube and allowing the vapour to cohobate in the space between the two glass tubes, he dispensed with all the arrangement of flask, tubes, and condenser.

Hofmann,[11] at the same time, made several modifications in his apparatus: 1. He proposed heating the whole length of the inner tube by making the outer one long enough to enter the mercury in the trough, and provided for the escape of the condensed liquid and excess of steam by having a small side-tube affixed a short distance above the level of the mercury. 2. Finding that graduated tubes were very liable to crack, he pro-

[1] *Ann. Chim. Phys.* [3], 63, 53. [2] *Wien. Sitz. Ber.* 53 [2], 92.
[3] *Liebig's Ann.*, 141, 273 (1867); *Phil. Mag.*, 34, 1 (1867).
[4] *Ann. Chim. Phys.*, 68, 428.
[5] *Ibid.* [3], 58, 257; "Watts' Dict. Chem.," 5, 373; *Compt. Rend.*, 45, 821; 49, 239.
[6] *Proc. Roy. Soc.*, 21, 203 (1873). [7] "Watts' Dict. Chem.," 5, 374.
[8] *Deut. Chem. Ges. Ber.*, 11, 1196 (1878); *Journ. Chem. Soc.*, December, 1878, p. 937. [9] "Cours de Chim.," 4, 71.
[10] *Liebig's Ann.*, 187, 341 (1877); *Journ. Chem. Soc.*, 1877, vol. ii., 697.
[11] *Deut. Chem. Ges Ber.*, 11, 1355; *Journ. Chem. Soc.*, January, 1879, p. 63. [12] *Phil. Trans.*, 1857, 460. [13] *Compt. Rend.*, 56, 891.
[14] *Trans. Roy. Soc. Edin.*, 22 [3], 441 (1861); *Ann. Chem. Pharm.*, 121, 01 (1862); 122, 247 (1862). [15] *Ibid.*, 98, 301 (1856).
[16] "Williams' Chem. Manip.," 542 (1857).

[1] *Ann. Chim. Phys.* [3], 63, 51 (1861).
[2] "Watts' Dict. Chem.," 5, 367.
[3] *Fresenius' Zeit. Anal. Chem.*, 1, 321 (1862).
[4] *Wien. Sitz. Ber.*, 53 [2], 92 (1866).
[5] *Compt. Rend.*, 78, 496 (1874); *Journ. Chem. Soc.*, 12, N.S., 648 (1874).
[6] *Compt. Rend.*, 78, 534. [7] *Deut. Chem. Ges. Ber.*, 1, 198 (1868).
[8] *Ibid.*, 3, 166 (1870); *Journ. Chem. Soc.*, 1870, 324; 1877, vol. i. 33.
[9] *Deut. Chem. Ges. Ber.*, 8, 1437 (1875).
[10] *Ibid.*, 9, 1419 (1876); *Journ. Chem. Soc.*, 1877. vol. i., 269.
[11] *Deut. Chem. Ges. Ber.*, 9, 1304 (1876); *Journ. Chem. Soc.*, 1877, vol. i., 33.

posed using plain ones in the following manner :—In the bottom of the mercurial trough he placed a piece of sheet india-rubber attached to an iron plate, and provided with a groove on its upper surface; the iron plate was furnished with a handle. During the heating the inner tube stood over the groove to allow of the escape of the mercury. When the level became stationary communication with the mercury in the trough was cut off by shifting the india-rubber disk until the inner tube rested on the flat surface. The height of the column in the inner tube was then noted by means of a cathetometer; the outer tube was then removed and a gummed label attached to the inner one to indicate the mercury level. After cooling, the volume of the vapour is determined from direct measurement. (3) In order to avoid the cracking of the tubes in cases where liquids of high boiling-point were used, he proposed connecting the lower end of the outer tube with the inner one by a cork through which two tubes leading to the flask or boiler passed. One of them led below the liquid, while the other, which was provided with a stop-cock, reached only just below the cork. If this stop-cock be closed while the liquid is being heated, a portion of it is forced up the space between the two glass tubes, and thus the mercurial column is heated more gradually. When the liquid reaches the boiling-point the stop-cock is opened, and the circulation of the steam proceeds as usual. The upper part of the outer tube must be sufficiently elongated or provided with a small tube leading to a condenser.

Brühl [1] proposed working the Hofmann method at a very low pressure by employing a tube 1·5 metres long, with only a small quantity of substance, and was therefore able to make determinations at temperatures far below its boiling-point. He also made the following suggestions:—

1. In order to eliminate the troublesome element of the tension of mercury vapour (without using two tubes as Grabowski did), heat the column to the required temperature, note its height, then allow it to cool, introduce the substance and heat again to the *same* temperature till the height is constant. To ensure uniformity of level in the bulb, keep it full to overflowing.

2. Before the first reading of the mercurial column a small piece of thin glass is passed up to liberate any air that may be contained in the mercury.

3. To make a mark on the tube a little above the vacuum mercury level and then only to calibrate about 150 mm. down from that point; then, to find the total volume, add the variable volume below the mark to the fixed volume above the mark.

Muir and Suguira,[2] in 1877, finding that sometimes the weight of the inner tube caused the groove in the india-rubber disk to so far close as to prevent the escape of the mercury while heating the substance, used a plain india-rubber disk which was fastened to the bottom of the trough, a disk of cork intervening. Communication between the mercury in the tube, and that in the trough was maintained by means of a short piece of glass tubing bent at right angles. A second tube long enough to stand slightly above the level of the mercury in the trough served to carry off, from the space between the two tubes, the condensed liquid and excess of vapour. They adopted Hofmann's original method of passing the steam in at the top of the outer tube, but used a small tube passing through a perforated cork in preference to one fused to the end.

Brühl [3] has, this year, proved by most carefully conducted experiments that the Hofmann method cannot be used above 220° owing to the great and rapidly increasing vapour-tension of mercury, but has omitted the grave objection to his own method. Playfair and Wanklyn [4] called attention, in 1861, to the fact that Bineau,[5] in 1846, pointed out that in vapour-density methods at very reduced pressures slight errors in the readings of the mercurial level introduce very serious errors into the result; this remark also applies to Croullebois.

In the overflow methods, which are in reality modifications of the Gay-Lussac, seeing that they are performed with known weights of substance, the first name is Hofmann,[6] who, in 1860, gave a very meagre description of his apparatus, when he wrote that he used a U-tube heated in a paraffin bath, and estimated the volume of the vapour by the mercury expelled. Wertheim,[1] in 1862–64, in his papers on Coniin, gave very full details of his method, in which he used two tubes suspended side by side in a flask.

Watts,[2] in 1867, employed a globe with a ground neck, into which an outlet-tube reaching nearly to the bottom of the globe was accurately fitted. The globe being filled with mercury and the substance introduced, the quantity of mercury expelled on heating served as a basis for calculating the volume occupied by the vapour. Victor Meyer,[3] in 1876, introduced two very important alterations, he avoided the vapour-tension of mercury by using fusible metal and placed the outlet at the bottom of the bulb. His experiments at that time were all made in the vapour of boiling sulphur, but Graebe,[4] last year, wishing to employ a higher temperature, used phosphorus pentasulphide, which boils at 530°.

Frerichs,[5] in 1876, used mercury in an apparatus similar in principle to that of Watts's, but employed an inverted flask, and brought the exit-tube, which was furnished with an inverted syphon, through a suitable outlet in the bottom of the bath.

Goldschmiedt and Ciamician,[6] in 1877, used mercury with the simpler bulb of Victor Meyer, but added a small side-tube to the outlet, so that the mercury expelled could be weighed from time to time during the heating. Victor Meyer,[7] in the same year, modified the shape of the bulb, but heated it in a tube similar to that employed by Greville Williams in Gay-Lussac's determinations, but of sufficient length for the upper part of the tube to serve as condenser.

Pfaundler's method,[8] of which a preliminary notice appeared in 1870, but which was not brought prominently forward till this year, is based on the increased tension of the air in an elongated bulb produced by heating after the introduction of the substance as compared with a similar determination on air in a bulb of the same size. A very short description appeared in 1874 of a method devised by Dulong [9] which is based on the same principle.

Last year Hofmann [10] proposed two methods; in one of these he heated the weighed substance over mercury in the closed limb of a U-tube, and marked the level of the mercury in the open limb by sliding a pointed tube through a loosely fitting perforated cork until it touched the surface. When the apparatus was cool, the volume of the vapour was calculated from the weight of mercury required to restore the level to that same point. The other consisted in introducing into a tube a small but weighed quantity of substance, then exhausting it and sealing it, and heating in a jacketed tube. At the required temperature the point of the glass tube is opened to allow air to enter, and then at once sealed again. After cooling, the point is opened under mercury or water, and the volume occupied by the vapour is measured.

In Meyer's [11] method, which is so recent and well-known as not to require any explanation, the principle is that of Pfaundler's, but by having the neck elongated and the outlet as a side-tube, the substance is introduced *after* the bulb is heated to the required temperature, and by allowing the air expelled by the vapour free egress into a graduated tube, it can be measured under atmospheric conditions. It is, therefore, so simple that the operation only requires a very short time from first to last.

Dewar and Scott [12] have lately determined the vapour-densities of potassium and sodium in a modified form of Meyer's apparatus.

In this sketch I have purposely kept off the very enticing ground of *formulæ*, as they of themselves open up so wide a field that they could not be dove-tailed into the history of the subject, which from *any* point of view is interesting.

1 *Deut. Chem. Ges. Ber.*, 9. 1368 (1876); *Journ. Chem. Soc.*, 1877, vol. i., 165; *Moniteur scientif.*, January, 1878, 14.
2 *Journ. Chem. Soc.*, 1877, vol. ii., 140.
3 *Deut. Chem. Ges. Ber.*, 12, 197 (1879); *Journ. Chem. Soc.*, 1879, abst., 499.
4 *Trans. Roy. Soc. Edin.*, 22 [3], 441 (1861).
5 *Ann. Chim. Phys.* [3], 18, 236.
6 *Phil. Trans.*, 150, 414 (1860); *Ann. Chem. Pharm.*, Supp., 1, 10 (1861).

1 *Ann. Chem. Pharm.*, 123, 173 (1862); 127, 81 (1863); 130, 269 (1864).
2 *Laboratory*, 1, 225 (1867); *Jahresbericht*, 1867, 31.
3 *Deut. Chem. Ges. Ber.*, 9, 1216 (1876); *Monit. scientif.*, January, 1878, 7.
4 *Deut. Chem. Ges. Ber.*, 11, 1646 (1878): *Journ. Chem. Soc.*, March, 1879, 260.
5 *Ann. Chem. Pharm.*, 185, 199 (1877).
6 *Deut. Chem. Ges. Ber.*, 10, 641 (1877); *Monit. scientif.*, January, 1878, 13.
7 *Deut. Chem. Ges. Ber.*, 10, 2068 (1877).
8 *Ibid.*, 3, 825 (1870); 12, 165 (1879); *Journ. Chem. Soc.*, 1879, abst., 499.
9 *Compt. Rend.*, 78, 536 1874)); *Journ. Chem. Soc.*, 12, N.S. 650 (1874).
10 *Deut. Chem. Ges. Ber.*, 11, 1684 (1878); *Journ. Chem. Soc.*, March, 1879, 196.
11 *Deut. Chem. Ges. Ber.*, 11, 1867 (1878); 11, 2253 (1878); *Chemical News*, February 14, 1879; *Deut. Chem. Ges. Ber.*, 12, 609 (1879); 12, 1112 (1879).
12 *Proc Roy. Soc.*, 29, 206 (1879).

ELECTRICITY AS A MOTIVE POWER[1]

THE lecturer commenced by referring to the stagnation of trade, to the various remedies that had been proposed to relieve it, and to the fact that while some were maintaining and others stoutly denying that commercial depression could be cured by legislation, we were too apt to forget that there existed a means by which, without lessening the wage of the workman or the profit of the master, the cost of production could be diminished, prices lowered, and the failing trade of England resuscitated. He next considered the consumption of coal for various purposes yearly in Sheffield, and showed that, although the price of coal in that town was very low, being only five shillings per ton for steam coal, the total annual cost for Sheffield alone must be something like 790,000*l*. Actual instances were then given of great saving being effected by water-power being employed on a large scale for doing mechanical work. Contrasted with this, calculation showed that at the Falls of Niagara as much power was wasted as could be produced by the total present annual consumption of coal throughout the whole world. And when it was remembered that there existed in the world other waterfalls besides Niagara, that we had also innumerable rapidly-flowing rivers, the important fact, well known to scientific men, but one which it was so difficult to induce the world at large to grasp, stared us in the face—that we obtained in a laborious way from the depths of the earth the power we employed, and we let run to waste, every hour of our lives, many, many times as much as we used.

Again, even in a perfectly flat country, where waterfalls were unknown, the question of the economic transmission of energy had no less interest, for large steam-engines could be worked much more economically than small ones, large steam-engines requiring a consumption of only two, or two and a half, pounds, of coal per horse-power per hour, whereas small steam-engines burned eight or ten pounds, or even more. And even where large economical engines were employed there was often, as in the gigantic cotton-spinning mills in Manchester, an enormous waste of power in the shafting used in transmitting it from the engine at the base of the factory to all the different floors, and parts of each floor, a waste so great that, in spite of the extreme inefficiency of small engines, it had been proposed, as an economical measure, to replace the one large steam-engine by many small ones, each driving two or three machines direct.

The lecturer then proved numerically that (contrary to the views expressed by some people) it was impossible to use economically in a town, for motive power, the water already brought in pipes to the houses for drinking purposes, since in most towns power so produced would cost about one shilling per horse-power per hour, and although in Sheffield the great head of the water would diminish this to about fivepence per horse-power per hour, still this had to be compared with considerably less than one farthing per hour the low cost in Sheffield of producing each horse-power with a very *large good* steam-engine.

Experience was leading us to see that it was to electricity that we must resort to obtain a carrier that would, at a small cost, transport our motive power over long distances, and as an illustration that the electric transference of energy on a large enough scale to be of practicable value was possible, knives were ground on the platform by power conveyed about a quarter of a mile through wires carried over the houses, a Siemens's dynamo machine being employed at the one end to convert into electricity the motive power supplied by a steam-engine, and a similar but smaller Siemens's dynamo machine being used on the platform at the other end to reconvert into motive power the electric current conveyed by the wires.

The principles on which dynamo-electric machines and electro-motors act were then entered into fully experimentally, and reference was made to the first electro-motor ever made—that constructed by Salvator del Negro in 1831—as well as to the improvements introduced into it by Jacobi, who replaced the oscillating motion by a rotatory one; different forms of modern electro-motors were then shown in action driving sewing-machines, &c. It was mentioned that although Jacobi abandoned his electro-motor used to propel a boat on the Neva because the fuel cost too much, still, that the subject of electro-motors was none the less practically important because we had since learnt why the old form was such an expensive producer of power, and what was the proper duty to be performed by electro-motors.

It was this very question:—Can an electric engine be made to work more economically than a steam engine? that first attracted Joule, of Manchester, in 1843, to commence that all-important investigation, which lasted for six years, the determination of the mechanical equivalent of heat.

Formerly, electric currents were almost entirely produced by galvanic batteries, in which zinc was burnt just as in the furnace of a steam engine coke was burnt. The amount of heat that could be got from burning a pound of zinc could be ascertained in the same way as the amount of heat produced by the burning of a pound of coal, but the fact that the latter was about seven times the former was of little value in the science of electro-motors, until Joule had proved that a certain quantity of heat was always equivalent to exactly the same quantity of work, no matter how the heat be produced; had proved in fact that energy was as indestructible as matter, a law which had for one of its proofs the long unsuccessful search for a perpetual motion.

As a result of this law of the conservation of energy Prof. Ayrton went on to show that since a pound of ordinary coal burning gave out seven times as much heat as the burning of a pound of zinc, we might say at once, that a steam engine would give seven times as much work as an electric engine for equal weights consumed, if in both cases all the heat could be turned into work; or, since zinc was about twenty-four times as dear as coal, that a steam engine would be about 150 times as economical as an electro motor, worked by a battery, if in both cases all the heat were converted into work.

But so far, he said, "we have only considered the law of 'Conservation of Energy.' There is, however, another, and no less important, principle called the 'Dissipation of Energy;' and this law tells us that although the energy of a system cannot by itself increase or diminish, yet our power to convert one form of energy into another is continually growing less, onr stock of available energy is gradually failing. Our mountain lakes, our vast store of coal, are practically useless until either the water is set in motion rolling down the hillside, or until the particles of the coal are set in rapid vibration as it slowly burns; energy of position, energy of chemical affinity, are of no use to the manufacturer until turned into kinetic energy or energy of motion. But from friction of various kinds, whenever energy exists in the kinetic form, some portion of it is being continually converted into heat. Whenever man or nature utilises energy it must be first turned into some kinetic form, and whatever be the aim of the special machinery employed some of this energy passes into heat. We cannot make even a clock go without regular winding up, although the only useful work done by the clock is to turn its hands at regular speeds; the earth's energy of rotation is now, like the moon's in past ages, gradually growing less, and is being converted into heat on account of tidal retardation; the earth, moon, and sun, and all the planets are losing their energies of motion and relative positions, to be all ultimately turned into heat.

"But at any rate, it will be said, there will still remain the heat, and since heat can be converted back into other forms of energy, we shall be none the worse off. But it must not be forgotten that whenever heat is produced some passes off by conduction through even our best non-conducting substances, and by radiation into space from even our best non-radiating surfaces; and this conducted and radiated heat, although it may impart some trifling warmth to unseen worlds, is for the greater part entirely lost to our universe. And even were it not so, even had we perfectly non-conducting coatings, and perfectly non-radiating surfaces—had we, in fact, the most perfect heat engine that our study of the science of heat would lead us to believe theoretically possible, one with no friction, no loss of heat by conduction through the sides of our cylinders, and no radiation from their surfaces—still our power to convert heat into other forms of energy would be very limited. For if there are two bodies, one hotter than the other, we can employ an engine, like a steam-engine, to convert part of the heat in the hotter one into some other form of energy; but the amount of heat converted, with even this ideal perfect engine, will, with such temperatures as are met with in practice, only be a fraction of what necessarily passes through the engine from the hot body to the cold, and warms up the latter; and as our whole power of conversion of heat into work depends on the difference of temperature, we lose it altogether when we have brought all parts of a system to the same temperature, no matter how high this temperature may be.

"It is not, therefore sufficient to say that the burning of a pound of coal produces seven times as much heat as the burning of a

[1] Abstract (by the author) of the British Association lecture delivered to 4,000 of the working-men of Sheffield, August 23, 1879, by Prof. W. E. Ayrton.

pound of zinc; but we must consider what fraction of the heat thus produced is converted into useful work in a heat and in an electric engine respectively.

"As already mentioned, our most perfect steam-engines can be made to produce one-horse power with the consumption of 2 lbs. of coal per hour. Now, the burning of 2 lbs. of coal will produce enough energy to raise 18,528,000 pounds one foot, or will produce 18,528,000 foot pounds of work. Now, one-horse power is equivalent to 1,980,000 foot pounds of work per hour; therefore, as regards the total energy in coal, even our best steam-engines only utilise $\frac{2}{9}$ of it, and waste $\frac{7}{9}$. But, as already mentioned, even a perfect engine cannot, with the ordinary temperature available, utilise the whole of the heat of the fuel. In fact, theory tells us that the efficiency of a perfect heat engine, or the ratio of the work done to the maximum work obtainable from the consumption of the fuel, is equal to the ratio of the number of degrees of temperature through which the steam is cooled in doing work to the highest temperature of our steam, when we take as our zero of temperature a point 460° below the ordinary zero of the Fahrenheit scale.

"Now, in our best steam-engines, the steam, when it begins to push the piston by expanding, has a temperature of about 300° F., and at the end of the stroke a temperature of 100° F., so that the efficiency of a perfect ideal engine working between these temperatures is only about $\frac{1}{4}$, not so very much greater than that of best practical engines.

"No great advance can be made, then, in a heat engine, except by making the temperature of the working substance, steam, gas, or whatever it may be, much higher. If, for example, we could raise the temperature of the working substance as high as, say, 3,000° F., the temperature of combustion, and could make it leave the engine without artificial cooling at the ordinary temperature of the air, which is, say, 60° F., then a perfect heat engine, under these conditions, would only waste about $\frac{1}{7}$ of the total energy; consequently, assuming that we could, at these high temperatures, make a practical engine as good relatively to an ideal perfect engine as we can at lower temperatures, then a practical engine would only waste $\frac{7}{43}$ of the total energy, or would have an efficiency of about 0·84.

"But, with our present knowledge, to work with steam or gas at a temperature of 3,000° F. is almost as ideal as an engine with no friction and with no loss of heat by conduction and radiation. We are, therefore, led to the conviction that as it is solely by working with steam at very high temperatures that the efficiency of steam-engines can be seriously increased, it may be well to consider whether it is not possible to economically replace the steam engine with some other form of motor."

It was then proved theoretically and experimentally that whenever an electro-motor is being worked by an electric current it is acting as a magneto-electric machine and producing a reverse current tending to stop the motion.

The lecturer then explained that, when an electro-motor is worked by a *given* galvanic battery, calculations lead us to the result that if we wish to produce the work *most economically* we must, by diminishing the load on the motor, allow its speed to increase until the reverse current it produces is only a little smaller than that sent by the battery; in fact, until the current circulating through the arrangement is very small, in which case the efficiency of the engine, or the ratio of the work it produces in a given time to the maximum work it could produce from the same consumption of material is nearly unity. If, on the other hand, we desire a *given* battery to cause the motor to do work *most quickly*, independently of the consumption of material, then calculation tells us that we ought to put such a load on the motor that its speed will send a reverse current equal to something like a half of the strength of the current the battery could send through the motor when at rest. In this case the efficiency is about $\frac{1}{2}$, or half the energy is wasted in heat.

He impressed upon the audience that the difference between these two considerations of maximum values ought carefully to be borne in mind, especially as it was usually the second—or how to obtain work *most quickly*—that had generally been taken into account, whereas it was the other one—or how to transmit work *most economically*, that would specially engage their attention during the lecture.

And in connection with the latter maximum value he said, "Let us consider that we work our motor in the most efficient way—that is very fast with a small load, and let us suppose as an extreme case that by so doing the efficiency is so little short of unity that we may regard it as one; then since an electro-motor worked by a battery in which zinc is burnt is 150 times as costly to maintain as a steam engine for equal efficiencies, the best electro-motor worked by such a battery will be thirty-three times as dear as our best steam engines having an efficiency of $\frac{2}{9}$. We may, therefore, throw on one side at once all idea of electro-motors worked by ordinary batteries, even although the electro-motors be perfect. Now, this result is most important, since it shows not that an electro-motor as a machine is inefficient, but it tells us that attempting to drive it with a galvanic battery is the hopelessly inefficient part of the arrangement.

"But if we turn to the question of using electro-motors for the transference of power, then there is no difficulty about burning zinc, and the high efficiency of such motors is all important.

"For in the case of natural sources of power, such as waterfalls, we have merely to consider what amount of energy will be produced at the distant factory; will it be sufficient to repay the expense of putting up wires from the source to the factory, together with the cost of the two dynamo-electric machines, or will it be cheaper to put up and use a small steam engine having probably an efficiency of only $\frac{1}{18}$?

"When the distance between the source and the motor is considerable, the cost of putting up the leading wires becomes important, and the question therefore arises, can two or more people use the same leading wires without increasing the thickness, or must the thickness of the wire be so much increased as to make the construction of two sets of leads as economical?"

Prof. Ayrton explained that he attached great importance to this question because the answer to it would decide whether the electric transmission of power was a mere dreamer's fancy, or was likely to have a real commercial future.

A detailed examination was then made of the laws governing the transmission of energy by water power, and as a result of the fact that the energy of a flow of water depends on the quantity and on its head it was shown that, as far as the waste of power by friction of the water in the pipes was concerned, a great pressure in the reservoir sending a small current to turbines in a town also working at great pressure was an extremely economical mode of transporting power, but that if we took into account the inefficiency of existing engines for producing a great pressure of water at the reservoir, combined with the great waste of power arising from even small leakages that were certain to be caused by the great water pressure, it followed that the system was an impracticable one.

An examination was then made of the laws governing the electric transport of energy, and the lecturer arrived at this result:—

"Just as we concluded in the case of the water, that the most efficient method to employ in order to transfer the energy, was great pressure in the reservoir, combined with turbines in the town working at a high pressure, so now we conclude that the most efficient way to transfer energy electrically is to use a generator producing a high electromotive force, and a motor producing a return high electromotive force; and by so doing the waste of power in the transmission ought, I consider, be able to be diminished with our best existing dynamo-electric machines to about 30 per cent.; for, as experiment shows the efficiency of our best existing dynamo-machines to be 0·86 (that is 86 per cent. of the power spent in revolving the bobbins is reproduced as energy of electric current); therefore, if two similar dynamo-electric machines be coupled up to transmit power, and if they are worked most *economically* in the general way I have already explained, and with the details of arrangement that I will enter into later on, instead of being worked so that the motor gives out power *most rapidly*, I have reason for expecting that the combined efficiency of the arrangement can be made to closely approach the square of 0·86, and not merely one-half, as commonly supposed.

"But while the two solutions of the problem are thus identical, there is this most important difference: increasing the pressure of the water means an uneconomical task, while increasing the electromotive force set up by a dynamo-electric machine, or an electro-motor, means merely running it faster, or running it at the same speed and putting more wire on the rotatory portion.

"And again, assuming that the mean electromotive force between the wire and the earth be as much as one hundred times the electromotive force producing the current, namely, the difference between the electromotive forces of the generator and of the motor, then with the ordinary insulation of the best land telegraph lines, less than one per cent. of the energy transmitted ten miles would be lost by leakage.

"It would be impossible to increase indefinitely the speed of revolution of the cylinder of an induction machine, since apart from mere mechanical friction the iron constituting the core of the revolving part has to be magnetised and demagnetised very rapidly as it revolves. Now, there is a physical limit to the speed with which this can be done, and in addition this rapid change of magnetism heats the iron very much. But experiment shows that at the ordinary speed of revolution of dynamo-electro machines, 700 turns per minute, the electromotive force is proportional to the speed. We are, therefore, very far yet from the limit of speed. Consequently it would be well for the transmission of power to attempt first, a considerable increase of speed in the generator, combined with so light a load on the motor, that its speed is also very high. When this begins to fail as larger and larger amounts of power are transmitted, then we might begin increasing the amount of wire on the revolving coils of each; but this, of course, has the objection that the loss of power from a given current would then become somewhat larger.

"In some of the dynamo-electric machines, the current that is sent through the external wires is the same as that which circulates round the fixed electro-magnets to create the magnetic field in which the movable coils revolve. Now, the small current which I am here advocating should pass between the generator at the one end of the line, and the electro-motor at the other, would be too small to properly magnetise the fixed electro-magnets of the two machines, so that even a high speed of the bobbin will not produce a high electromotive force. But this difficulty is easily overcome by the plan already employed, for totally different reasons, by Gramme, Lontin and Wilde, in their generator for producing currents for electric lighting, viz., that of using either a separate exciter, or a separate portion of the revolving bobbin in the generator, to produce the current to magnetise the fixed electro-magnets. In connection with this current for exciting the fixed magnets, it is worthy of notice in passing, to observe that since experience shows that the electromotive force of a dynamo-electric machine is proportional to the velocity, I conclude that the magnets are saturated, and that the exciting current is already too strong, so that it may be with advantage reduced, or many fewer coils of wire employed in this portion of the machine.

"We have then been led to this most important result which I hope is clear to you all, and which I trust you may all carry away with you—*that a dynamo-electric machine, with a separate exciter, driven very fast with a steam engine, or with a stream of water, at high or low pressure, and sending, by even quite a fine wire, a small current to a distant electro-motor, also running very fast and magnetised by a separate exciter, is an economic arrangement for the transmission of power.*"

An examination was then made of the way this result was affected by increasing the length of the connecting wires, and it was proved that the electric transmission of power was not only practical, but also very economical, both for short and long distances, if the generator of the electric current at one end of the line and the motor, worked by this electric current, at the other end of the line, were both run fast enough, and if only we required to transmit a sufficiently large quantity of power.

The lecturer then went on to say, "We have been considering the transport of power derived more especially from natural sources; but since we have seen that by the use of electricity, properly employed, the waste of power in transmission can be reduced for any distance to about 30 per cent. of the whole power absorbed at the generator, it follows that the employment of steam-engines of vast size at points outside Sheffield would be by far the most economical mode of extracting the energy out of coal. For it is at least four times as expensive to produce power with a small steam-engine as with a large one; therefore, including the waste of power in electric transmission, the cost of production of power in small workshops would be little more than one-third as dear as if small steam-engines were used, and similarly the waste of power in any large mill or factory in its transmission from the large steam-engine at its base to all the floors and machines on each floor would be very much diminished.

"Consequently it would be much more economical to work this lathe on the platform, as I will now proceed to do, by a big steam-engine in Howard-street, several hundred yards away, than to use a small steam-engine here for this purpose."

He then reminded them that not only can electricity produce motive power, but also light and heat, and electric heating and lighting had this great advantage, that no chimneys were required. Experiments were then made of boiling water and lighting the Albert Hall by an electric current generated a quarter of a mile away.

Reference was then made to the great money-saving of something like 30*s.* an hour, that Dr. Siemens had been able to effect at the Albert Hall, London, by replacing the old gas jets by electric lamps giving even more light, and to the unexpected advantage attained by the present stillness of the air arising from the use of the electric light, and which enabled the singing and music there to be better heard now. Great weight was attached to the fact that at the Albert Hall the science of hanging a brilliant light high up had been luckily allowed to ride over the precedent of putting a number of feeble glimmers all over a building, and in connection with this it was explained that the reason why electric lighting for streets had been economically much less successful, was because English conservatism had prevented the authorities from realising the possibility of using for street electric illumination anything differing from an ordinary iron lamp-post. Attention was then drawn to the fact bearing most closely on the economy of electric lighting on a large scale, and which had been obtained as the result of experiments, that the larger were the dynamo machines used for producing the electric light, the more light was produced per horse-power. Taking all this into consideration, Prof. Ayrton arrived at the result that "at any rate we may be absolutely safe in saying that the cost of using gas in Sheffield for lighting large halls, such as the one we are now in, factories, and the streets could be halved if electric currents, generated by water engines worked by hill streams, as well as by very large steam engines, were substituted for gas.

"But can this be quite right, for I have proved that to transfer energy economically we must use a large pressure and a small flow. Now, how can we produce a very bright electric light with a small current? Why, by not using the current that comes along the wire to produce the light at all, but merely to drive an electro-motor, which motor, at the place where any large amount of light was required, would be employed in giving motion to a second dynamo-electric machine, which would produce the currents for lighting purposes.

"This experiment I might show you, but as we have used already several times during the evening electric lights fed from a distance, we will vary the experiment and try an analogous one. Messrs. Walker and Hall will now, at their works, give rapid motion to a dynamo-machine, and the current which, when properly arranged, as I have explained to you, may be small, will set in motion this electro-motor. This in its turn will cause this other dynamo machine to rotate rapidly and produce a current which I will use for rapidly gilding this piece of plate."

Calculation showed that if electric currents generated by very large steam engines at certain points, and by turbines driven by the falling water on the hillsides round Sheffield, were substituted for the use of coal for motive power, smelting, heating, and lighting buildings, that a saving of something like 400,000*l.* a year might be anticipated for that town; and as an argument to prove that although such a reform was startling in its economical bearing, it might nevertheless be sound, the following was adduced:—Imagine the cost of cutlery and plated goods to remain as at present, but all machinery to be removed from Sheffield, then what an enormous loss would accrue to the town from everything having to be done by hand labour. The saving then which the lecturer was showing the audience how to obtain, enormous though it might be, was still small compared with the gain that the introduction of machinery during the last hundred years had effected for that town.

Next was considered whether the Sheffield Water Company had any water in their reservoirs that could be spared for producing motive power, since of course the water which did work at its source would lose head and so be unable to come to the tops of the houses in the town as at present, and it was shown that there was a considerable surplus supply. As an illustration of such a use of the water power, a two inch board was sawn on the platform by a circular saw, driven by an electric current generated by a water engine in the yard of the Water Works, and conveyed to the Hall by wires crossing the streets.

As a practical illustration of what had been done the lecturer said:—"Last year two French engineers, MM. Chrétien and Felix, at Sermaize (Marne), actually ploughed fields by electricity, the electric current being produced by two dynamo-electric machines, of a form invented by M. Gramme, and shown in the diagrams on the walls. These machines were usually worked

with a steam engine at some convenient place three or four hundred yards away in an adjoining road, and the electro-motors were also two Gramme machines, one on each side of the field, with their coils revolving of course backwards. Through one of these, the electric current was sent alternately, so that motion was given to one or other of two large windlasses, one on each of the waggons containing the electro-motors. In this way the plough, which could be used going in either direction, was first pulled across the field making a furrow, and then back again making another parallel furrow."

A photograph taken on the spot, of one of the complete Gramme electro-motors, with its windlass and waggon, together with the double acting plough, was projected on to the screen.

A second photograph was also now projected on to the screen of M. Chrétien's electric crane for unloading boats. This too, the lecturer said, had been successfully employed for several months at Sermaize, in the harbour there, and it was considered that a saving of about thirty per cent. had been effected of the expense formerly incurred for unloading the sugar barrels out of the boats.

Reference was then made to the difficulty that would be experienced in distributing electric power properly on account of the current in any curcuit being affected by any alteration in any other circuit connected with it, and it was explained how this difficulty was met by the electric current regulations of M. Hospitalier and Dr. Siemens. Another difficulty arising from the velocity of the water on the hill streams being great after floods and small in dry weather, and which at first sight might appear to require an extravagant supply of dynamo machines so that even in a draught sufficient power could be transmittted electrically, it was explained, could be overcome by storing up the electric energy as compressed gas, and it was shown that a square foot of hydrogen at thirty atmospheres pressure (the usual pressure in the iron gas bottles of commerce) combining with half a cubic foot of oxygen, at the same pressure, would develop no less than 110 million foot pounds of work.

Prof. Ayrton concluded by asking:—

"But is there no other side to this question? We are, it is true, a commercial people, but do we not still love our hills and our fields? There was a time when the cutler of now black, grimy, Sheffield was very fleet of foot in following the chase. There was a time when 'Not only in the villages around old Sheffield,' so says the history of Hallamshire, 'were the file-makers' shops or the smithy to be seen, with the apprentices at work; but even on the hill side in the open country, at the end of the barn would be the cutlers' shed whilst in the valley below, by the river, was the grinding wheel ready to sharpen the tools that had been manufactured.'

"And why not now? why should not that mountain air that has given you workmen of Hallamshire in past times your sinew, your independence of character, blow over your grindstone now? Why should not division of labour be carried to its end and power brought to you instead of you to the power? Let us hope then that in the next century electricity may undo whatever harm steam may have done during the last, and that the future workman of Sheffield will, instead of breathing the necessarily impure air of crowded factories, find himself again on the hill side, but with electric energy laid on at his command."

THE ANTIQUITY OF MAN

AT the Sheffield meeting of the British Association Prof. Boyd Dawkins, in the course of a paper "On the Antiquity of Man," said he presented before them a diagram showing the divisions of the tertiary period, the third of the three great life periods which had been presented on the earth. When he examined those stages before the highest forms of life, he was confronted with this most important fact: in the eocene age they had not a single species of placental mammal, nor did they meet with any indications of a living placental genus. No species now found in Europe were found in the eocene age. It was absolutely impossible to suppose that man was living on the earth in eocene time, yet there was no reason, because of climate and vegetation, that he should not have been. Then they came to the miocene age, when they found not merely living families and orders, but living genera. Putting man out of the question, there was not a single well-authenticated case on record in any part of the world of any mammalian species now living on the earth having lived in the miocene age. The French preserved a flint flake which was found at Thenay, and which they say is of the miocene age; in fact it was accepted by a great majority of the French archæologists that man was living in the miocene age. The French held that flints found, and all of them bearing traces of manufacture, were of the miocene age, and the work of man. It was far less difficult to believe that these flints were the work of some of the higher and extinct forms of mokeys, than it was to believe that they were the work of man. In the pliocene age they found one or two living species making their appearance. Prof. Capelini had called attention to the fact that certain cut bones, which were asserted to be of the miocene age, had been cut by the hand of man. On one of those bones there were cuts which were done by the hand of man. The cuts were distinctly artificial, but the difficulty which presented itself to his mind was this. He was by no means certain that those bones, which were said to have been found in the pliocene strata, had been discovered in undisturbed pliocene strata. It was not clear to his mind that the mineralisation of those bones would not take place long after the pliocene age had passed away. He urged his objections to the accepting of specimens said to have been got in the pliocene age when there was no good authority for saying that such was the case. He then passed to the pleistocene, by some called the glacial period. Then living species were very abundant, extinct species very rare, and it was in that age that they met with man in considerable abundance and scattered over a very wide area. The evidence presented from time to time, in the first place out of caverns, and on the other hand out of river deposits, showed beyond a doubt that man was present in Europe in full force in the pleistocene age, and he came in just when it might be expected he would come in. In the pleistocene age they met with man as a mere hunter, not as a farmer or possessor of wild animals. He mentioned that because during the last two or three years it had been asserted that man was possessed of domestic animals in the pleistocene period. The pre-historic period which succeeded the pleistocene, was characterised by the absence of the extinct species of mammalia, with one exception. The one extinct animal which extended upward into the pre-historic age was the Irish elk. The great characteristic of the pre-historic age was the calling in of the domestic animals, the dog, sheep, horse, various breeds of hog, cattle—all coming in under the care of man, all spreading over Europe; and along with them they had the getting of cereals and fruits, and the cultivation of the arts of agriculture. They had in that period just those very things which formed the foundation of that civilisation which they themselves spread, and which had been built upon the foundations of the neolithic age. The pre-historic period was divided into the neolithic, the bronze age, and the age of iron. The pre-historic age was divided from the historic, because the former was not represented to them in historic records. In conclusion he ventured to express an opinion as to how happy they would be if they could get hold of a date and fix the antiquity of man in Europe in terms of years. It would be most delightful if they could fix the first presence of man at Creswell Crags, say within some thousands or hundreds of thousands of years. He could not help thinking that all their hopes of that description would be vain, as there were intervals, and they could not know without the written record, the duration of the intervals which separated one period from another.

UNDERGROUND TEMPERATURE[1]

THE temperature of the surface of the ground is not sensibly influenced by the flow of heat upwards from below, but is determined by astronomical and atmospheric conditions. The rate of increase in travelling downwards from the surface may conveniently be called the *temperature gradient*, and averages about 1° F. for fifty or sixty feet. This is about five times as steep as the temperature gradient in the air.

If we draw isothermal surfaces for mean annual temperature in the ground, their form beneath mountains and valleys will be flatter than that of the surface above them. This is true even of the uppermost; and the flattening increases as we pass to lower ones, until at a considerable depth they become sensibly horizontal planes. The temperature gradient is consequently steeper beneath gorges and least deep beneath ridges.

In a place where the surface of the ground and the isothermal surfaces beneath it are horizontal the flow of heat will be vertical,

[1] "On some Broad Features of Underground Temperature," by Prof. J. D. Everett, F.R.S. Abstract of paper read at the Sheffield meeting of the British Association.

and the same quantity of heat will flow across all sections which lie in the same vertical. In this case the flow across a horizontal area of unit size will be equal to the product of the *temperature gradient* by the *conductivity*, if we employ the latter term in an extended sense so as to make it include convection by the percolation of water, as well as conduction proper. It follows that in comparing different strata lying in the same vertical, the gradient will vary in the converse ratio of their conductivity. It seems probable that the same law of inverse proportion between gradient and conductivity holds approximately even when the strata compared are not in the same vertical but are widely distant.

As regards the modes of observation which have been employed for the determination of gradients:—shafts full of water, and wells of large diameter, afford so much facility for equalisation of temperature by currents between the colder water above and the warmer water below, that they furnish no useful results. Even in bores of small diameter the same disturbing cause exists and always makes the observed less than the true gradient.

Observations in mines will be vitiated by the presence of pyrites, which generates heat by its slow combustion, and are also liable to be vitiated by strong currents of air; but when they are taken at the newly exposed face of a gallery which is being driven into the rock, care being taken to prevent strong air-currents at the place, and the surrounding ground not being too much honeycombed by previous excavations, good results may be obtained. A hole should be bored to the depth of about two feet in the newly exposed face, the thermometer inserted, and the hole plugged with clay.

SCIENTIFIC SERIALS

American Journal of Science and Arts, September.—In the opening paper, on the pertinacity and predominance of weeds, Prof. Asa Gray, from an examination of European weeds which have taken a strong hold on the United States, opposes Mr. Henslow's view that plants best fitted for domination as weeds are in general self-fertilised plants, and owe their predominance to this. He also regards the "greater plasticity" assumed by Prof. Claypole for European as compared with American plants as purely hypothetical.—In view of the variations in amount of oxygen in the atmosphere of a given place (sometimes by as much as one-fortieth of the average, and often the one-hundredth or two-hundredth part), Prof. Morley calls in the theory by which Prof. Loomis accounts for certain great and sudden depressions of temperature at the earth's surface, viz., by vertical descent of cold air from the higher parts of the atmosphere. The lower air at such times might well contain a less proportion of oxygen than the average. Pending systematic observations at points Prof. Loomis has indicated, the author here describes at length his method of analysis, and the results of observation on samples of air collected at home; these seem to lend some support to his theory.—A remarkable meteorite fell at Estherville, Emmel Co., Iowa, on May 10; one mass weighing 431 lbs. was found fourteen feet under the surface of the ground in a ravine, and, besides several small masses near, a mass of 151 lbs. about two miles westward. Prof. Shepard, from specimens in hand, regards this meteorite as a connecting-link between the litholites and lithosiderites, unless it be placed as a separate order in the Eucritic group of the former.—Prof. Marsh announces the discovery of two new lower jaws belonging to the genus *Dryolestes* (of Jurassic mammals).—Remaining papers:—On the colour correction of achromatic telescopes, by Mr. Harkness.—Reply to Principal Dawson on *Eozöon canadense*, by Prof. Möbius.—Terminal moraines of the North American ice-sheet (continued), by Mr. Upham.—New observations on planetoids, by Mr. Peters.—Observations on the genus Macropis, by Mr. Patton.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, September 29.—M. Daubrée in the chair.—The following papers were read:—On the development of the perturbative function in the case where, the eccentricities being small, there is any mutual inclination of the orbits, by M. Tisserand.—Construction of the international geodetic standard, and determination of its controlling weights, by MM. Sainte-Claire Deville and Debray. The method is given in detail.—Studies on the effects and mode of action of substances employed in antiseptic dressings, by MM. Gosselin and Bergeron. The method was to put blood, then pus, in contact with various antiseptic agents (including solutions of carbolic acid of various strength, camphorised alcohol, camphorised brandy), and noting the effects, both with the naked eye and with the microscope. The antiseptic agent was in some cases put in glasses with the blood or pus, sometimes applied by means of evaporation and pulverisation. The result is specified in each case; the 20 per cent. solution of carbolic acid, alcohol, and camphorised alcohol, seem to have prevented putrefaction best.—Theoretical essay on the law of Dulong and Petit; case of solid and liquid bodies and vapours, compound bodies, by M. Willotte.—Vibratory forms of bubbles of glyceric liquid, by M. Decharme. A bubble is supported on a thin watch-glass fixed at the end of a vibrating plate or rod; it follows and amplifies the vibrations, and with favourable conditions one can see distinct nodes and ventral segments, whose number varies with the velocity of vibration and diameter of the bubble. Three laws are given: (1) With a given number of nodals, the diameters of the bubbles are proportional to the lengths of the vibrating plate, or inversely proportional to the square roots of the numbers of vibrations. (2) With a given diameters of bubbles, the numbers of nodals are inversely proportional to the lengths of the vibrating plate, or directly proportional to the square roots of the numbers of vibrations. (3) With a given length of vibrating rod, the numbers of nodals are proportional to the diameters of the bulbs. These experiments generalise that of Melde by extending it to spherical surfaces, and even to volumes, for the author has found that thin balloons of caoutchouc filled with water behave like bubbles.—On the presence of alcohol in the animal tissues during life and after death, in the case of putrefaction, from the physiological and toxicological point of view, by M. Bechamp. Horse-flesh (3 kg.) plunged for ten minutes in boiling water, to coagulate the surface, then inclosed in a vessel, was examined after a month. About 0·8 gr. of alcohol was got from the interior, and 10 gr. of salts (acetate, butyrate, &c.) of soda. (There were numerous bacteria; no vibrion.) 4 kg. left to itself four days gave less alcohol. Thus putrefaction is essentially similar to fermentation; and specially so to butyric. M. Bechamp also found alcohol in various healthy animal tissues (brain, muscles, and liver).—Action of sulphide of carbon liberated in a slow and prolonged way on the vine, by M. Rohart. This is more efficacious than the brief application, and does not injure the plant.—Discovery of two small planets by Mr. Peters.—Action of metallic nitrates on monohydrated nitric acid, by M. Ditte.—Thermal study of succinic acid and its derivatives, by M. Chroustchoff.—On a new curare extracted from only one plant, *Strychnos triplinervia*, by MM. Couty and De Lacerda. This is less active than the other, but easy to obtain in large quantity. It gives in a few seconds a curarisation which may be arrested in its different periods.

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THURSDAY, OCTOBER 16, 1879

POLAR ICE

Die Metamorphosen des Polareises. Von Karl Weyprecht. (Wien, 1879: Moritz Perles.)

THIS book of Karl Weyprecht's is a most valuable outcome of the Austro-Hungarian Arctic expedition of 1872–1874, so well known already from the interesting general popular account of the doings of the expedition which has been published in most European languages. In the present work the author confines himself to an account of the phenomena presented by the ice amongst which he spent so many weary months. It might well be supposed that a book treating of such a subject only would be dull reading, but so graphic are Lieut. Weyprecht's descriptions, and so pleasantly are his long series of observations strung together into a continuous whole, that his book is most entertaining throughout, and the reader lays it down with a very much enhanced comprehension of the never-ceasing changes and mighty power of Arctic ice. Most of the facts recorded are known to Arctic explorers, and have been more or less set forth by them in their various writings, but no connected account of all the forms of the growth and death, of the movements and struggles of bergs and floes and ice of all forms has been before attempted Lieut. Weyprecht tells it us all from his own observations. The book is divided into a series of chapters headed as follows:—I. Various Forms of the Ice and their Origin. II. Ice-pressures. III. The Ice in Winter. IV. The Ice in Summer. V. The Changes of the Ice. VI. The Water Movement in the Polar Regions. VII. The Ice Movements. VIII. The Ice of the Arctic Interior.

In the first chapter he treats of the three different kinds of Polar ice: glacier ice, salt-water ice, and fresh-water ice. As an example of the mighty size of the Polar glaciers, the parents of the icebergs, he cites the Humboldt glacier of Smith Sound, which, pushing itself into the sea in Smith Sound, forms an unbroken ice coast-line composed of perpendicular cliffs 300 feet in height above the sea-level, and 60 miles in length, a single solid ice wall split only by vertical fissures. The fresh-water ice is clear as crystal, and so hard that the Norwegian walrus-hunters who run their small vessels in their voyages against all other ice obstacles, of whatever size, are careful not to charge even comparatively small pieces of this. This kind of ice is, however, scarce in the polar regions; it is the third kind of ice, that of salt water, or "field-ice," which forms by far the greater part of floating ice, and with which the book is mainly concerned. The *Tegetthoff* was shut in for a year in field-ice, and the author watched the incessant changes in the ice with great care throughout this period.

A simple smooth sheet of sea-water ice is no sooner formed than it begins to be subjected to a variety of influences, which speedily convert its smooth expanse into a complicated rugged surface, covered with ridges, valleys, and irregularities of all kinds, render its thickness everywhere unlike, and split it up with innumerable fissures. Most important amongst the causes of these changes are the variations of temperature to which the ice is exposed from the variation of that of the water below and the air above, and which are more or less local, and affect the ice differently wherever its thickness varies. From these differences of temperature ensue complicated strains in all directions, due to the unequal expansion and contraction of the mass, and the ice is rent by the tension; to these forces is added the pressure of surrounding ice-fields, driven by the action of winds or currents; long fissures are formed, the edges of which grind together with mighty force. After a while the edges separate, and the water between pulsates with the throbbing of the surrounding floes. Again they come together, and forced against one another with ever-increasing power, they are crushed and break up, huge blocks are piled above on the ice-surface, resting at all angles upon one another, and other huge blocks are forced under the ice below. Hence the ice becomes rugged above, and by the freezing to it of the blocks forced under water, equally so below, the variation in thickness is increased, and with it the amount of strains caused by variation of temperature. The drifting snow hangs against the ridges and pinnacles on the surface, and forms banks and mounds which not only increase the effects due to temperature by protecting the areas on which they lie from change, but also by their immense weight, combined with that of the projecting ice-masses by which they are formed, press down the ice which supports them, whilst the blocks below in other regions press it up. Throughout the mass gravity acts as a disturbant, no part being water-borne at its natural level, the mass is strained, and gives way in all directions, and fresh complications ensue.

All these changes are accompanied by a noise. The unlucky prisoner in the field-ice during the imposing unbroken loneliness of the long Arctic night, when the wind is calm, can hear the crackle of the snow under the stealthy tread of the Polar bear at an astonishing distance, and hear what a man, speaking loud, says at 1,000 metres distance. It can, therefore, be well understood how the sound of the ice-pressures must travel to his ear from enormous distances. "Sometimes," the author writes, "the noise of the ice movements was scarcely to be heard —a mere murmur—and came to our ears as does the play of the waves on a steep coast from the far far distance. Sometimes it hummed and roared closer to us, as if a whole column of heavily laden waggons were being drawn over the uneven ice surface." In the sound were combined all manner of noises caused by cracking, grinding, falling of blocks, crushing, and many other phenomena of ice-life. "It is astonishing how far and how clearly every noise is conducted in the ice. The noise at the very margin of the field on which we were seemed to occur immediately at our feet. . . . If we placed our ears to the ice the sound was heard so loudly that we might have expected the ice to open under our feet the next moment. The whole dry ice covering was as a vast sounding-board. Whenever, as I lay down to sleep, I placed my ear against the dry wooden ship's side, I heard a humming and buzzing which was nothing else but the sum of all the noises which occurred in the ice at great distance from the ship."

A curious fact is described by the author, that the surface of an expanse of young salt-water ice on which no snow has yet fallen is soft, so that the footstep is impressed upon its white covering as in melting snow. This is to be

observed even at a temperature of $-40°$ C. The unfrozen fluid is not water, but a concentrated solution of salt thrown out by the freezing of the ice beneath.

When summer begins, the thawing that occurs is very local and unequal. Any dark body, such as a heap of ashes or the droppings of bears, eats its way into the snow, absorbing the rays of heat which are reflected off again by the general white surface. The bear droppings eat their way into the snow, and then into the ice, and the conical hole thus formed fills itself with water. It may, at last, eat its way right through the ice where not very thick. Thus are formed the greater part of those holes in drift-ice which are usually ascribed to seals. The author never saw a seal's hole in winter.

A number of interesting experiments were made on ice phenomena. For example, on March 5, a cube of ice was sunk under the ice-field to a depth of five metres. After a lapse of twenty-four hours it was found that a crust of new ice had formed itself over it about 1 cm. thick. This was caused by the low temperature of the block itself and, from a similar cause, ice-crystals had formed between the edges of the hole, owing to the coldness of its walls. On March 10 very little increase in the added layer of ice on the cube was to be observed. On March 20 this newly-formed ice was found to be softened so that it was easily impressed by the finger; by April 2 it had become harder again, though porous and apparently a little increased. From thence onwards the block dwindled regularly, especially on that part of its surface which was turned upwards; on July 18 it was only a third of its original size; nevertheless, the hole through which it was sunk had, during the last period, become entirely closed by young ice at its lower margin. This experiment shows the loss of ice from below by the action of the warmth of the water. The author concludes from his experiments and measurements that compact salt-water ice can never attain a greater thickness than 10 metres.

Icebergs are subjected to disintegration after somewhat the same manner as rocks so commonly are. They are full of crevasses, into which the water formed by melting penetrates; in winter this water freezes, and by its expansion all through the glacier a rupture of the mass ensues. "It is highly probable that most of the icebergs afloat in winter are in such a condition that a very slight cause is sufficient to make them burst because of their state of internal tension. . . . Every polar traveller can tell how a shot, the driving-in of an ice-anchor, or any other sudden vibration, has brought about the catastrophe; cases have even occurred in which the sound of the voice alone was sufficient. An iceberg is always an unpleasant neighbour." So many are the causes which tend to destroy icebergs that the author concludes "no berg exists which could withstand them more than ten years, and that commonly the life of a berg is much shorter." However this may be, doubtless the much larger Antarctic bergs last very much longer, as must necessarily occur because of the much greater uniformity of the climate to which they are exposed.

With regard to glaciers, the author quotes an interesting observation of Kane's to the effect that even in lat. 78° 20′ during the entire winter, however low be the temperature, the glacier streams never dry up. The melting which supplies them with water can only derive its requisite heat from the friction of the ice-masses.

The chapter on the ice-movements is full of interest. Every field acted on by winds and currents has its own peculiar velocity, depending on the dimensions of the irregularities above and those of the resistances below, in which no two fields are alike. From these differences of velocity arise the irresistible pressures between contiguous fields. The iceberg deeply sunk drifts but slowly, whilst the ice-field may travel very fast. If the field catches up a berg in its course, it is broken and torn by the berg; and as it proceeds on its course its broken fragments are piled up block upon block on the coast of the iceberg. To a casual observer it appears as if the iceberg, driven by a counter current below, were being forced in the opposite direction to the ice-field, so as to plough it up. Many groundless accounts of the existence of such counter currents thus observed have been circulated.

Another cause of pressure between ice-fields is that, owing to the irregularities on their surfaces, they are twisted round by the action of the wind, which takes hold more on some regions than others. Every field is differently thus acted upon for each direction of the wind. A similar effect is caused by the currents beneath acting upon the irregularities of the under surface. So various are the movements in the ice-fields, that even when the ice lies all the while closed, it is very seldom that any two pieces remain for any length of time in the same position alongside one another. Two ships beset together by the ice are sure sooner or later to be separated.

The author fully admits that the danger incurred by explorers in the Antarctic regions is very much greater than that to which Arctic voyagers are exposed. The fog in the south is a terrible enemy, and there a ship cannot at once take refuge in the field-ice as in the north. He urges, however, the necessity for scientific Antarctic exploration and observation, and suggests that a wintering in the lands lying south of Cape Horn could be easily accomplished, and would not require any very extensive appliances. We fully agree as to the benefit to be derived by science from a round of meteorological observations and all other kinds of scientific exploration in the Antarctic regions, and heartily wish that such enterprise would take the place of the constant struggles to get to the North Pole. By the mere reaching of the pole there is nothing to be attained. A steamship could very possibly run down from New Zealand direct to Mount Erebus and Terror in a fortnight during the summer months; such an attempt has never been made. It need not be very costly, and possibly the Government of one of the Australian colonies may make it some day. We commend Karl Weyprecht's book to all who study ice phenomena, but not only to specialists, for it is full of interest to all intelligent readers. H. N. MOSELEY

THE SILK GOODS OF AMERICA

The Silk Goods of America. By Wm. C. Wyckoff. (New York: Van Nostrand.)

THIS book has been issued under the auspices of the Silk Association of America, with the view of affording information as to the character of the silk goods manufactured in that country. Not many years since

nearly all such goods were imported, and even now the entire product of many of the American silk mills is represented to the consumer as of European make. The Silk Association have, however, bestirred themselves; they find that in order to obtain a standing in a market where imported articles hold an established reputation they are obliged to make better fabrics than their foreign rivals, and, naturally enough, they now seek to secure for themselves the credit of their enterprise. The Centennial Exhibition startled the manufacturers both of this country and of France with the extent and rapidity of their progress in developing this special branch of industry. The railways across the Continent and the direct trade with Asia across the Pacific Ocean have placed America more nearly on a level with European countries as regards supplies of raw silk; improvements in the power-loom and the continuance of the tariff policy of the Government have done the rest. Mr. Wyckoff boldly states that had that policy vacillated during the last ten or fifteen years there would have been no story of improvement to tell.

One of the main difficulties with which the American manufacturer had to contend was the want of skilled labour, and this was more especially felt in the production of black dress goods. On account of the necessity of securing perfect equality in the threads, such goods are far more difficult to produce than are more highly ornamented fabrics, but although the manufacture of broad black silks on anything like a large scale has only been attempted in America during the last half-dozen years it is estimated that fully a third of the plain silks and a much larger proportion of the brocade silks which are consumed in that country are made there. Indeed Mr. Wyckoff states that the advance in this branch of manufacture within the last three years is greater than that in any other department of American silk industry. Nor is the reason for this far to seek. The American manufacturers, as a class, have studiously set their faces against the abominable system of "loading" which prevails so largely on this side the Atlantic. Nearly all European broad black silks are doubled, nay, sometimes even trebled, in weight in the dyeing of the yarn. This is how the "Black Art" is practised in France. The yarn is repeatedly dipped in nitrate of iron until sufficiently weighted, after which it is passed through a bath of prussiate of potash and then treated with gambier and acetate of iron. To brighten it it is next passed through a logwood bath and well soaped; if it is to be soft and satin-like it is oiled and treated with soda; if it is to be stiff and rustling it is dipped in acid. No wonder after this that the black silk with its load of grease and iron wears shiny, and cracks in the folds. "It is asking too much to demand that the few strands shall act as iron-mine, soap-factory, and chemical laboratory all at once and stand the wear of practical use besides. These are requirements before which the English attempt to make a grocery store out of a shirt pattern is a simple and ordinary matter." Nothing is easier, however, than to discover this loading of dye-stuff. If ladies would insist on being allowed to test a small sample of the silk, at home, before purchasing, by the very simple operation of burning it, the sophistication would speedily perish. Pure silk crisps instantly on burning, and leaves a small quantity of charcoal; loaded silk smoulders slowly to a yellow ash. Not many years ago men's coats were largely trimmed with black silk braid; but now, as a maker in the article was heard dolefully to declare, "the trade in black braids is as dead as Julius Cæsar," for we have naturally got disgusted with the frayed and brown appearance which the article generally assumes after a week or two's wear, thanks to the fact that it usually contains more dye-stuff than silk. The public is gradually awakening to a knowledge of these things, just as surely as the patient Hindoo and the heathen Chinee have had their eyes opened to that miserable compound of starch, cotton, China clay, and Epsom salts which the Manchester merchants have palmed off upon them as genuine shirtings.

Let the silk manufacturers take warning: to meet falling markets with inferior goods dressed and dodged so as to simulate a better article is simply to hasten on the time of trouble and disaster. Markets have reputations as tender as that of Cæsar's wife. If such malpractices continue we shall soon be clamouring, in the interests of commercial morality and of national prosperity, for an extension of the Adulteration Act from our Food to our Clothes.

DARWINISM AND OTHER ESSAYS

Darwinism and other Essays. By John Fiske, M.A., LL.B., formerly Lecturer on Philosophy, Instructor in History, and Assistant-Librarian at Harvard University. (London: Macmillan and Co., 1879.)

TO readers of NATURE there is nothing new and little very striking in these essays, and it is only justice to Mr. Fiske to remark that the title of the first, which gives its name to the volume, claims nothing of the sort. The most interesting consideration in the four papers upon the subject is the marvellous way in which every science and line of thought, both in natural history and in human history, have entirely changed their aspect and started in a new direction since the publication of "The Origin of Species." One fourth of the book is a review of Mr. Buckle's "History of Civilisation," written and published by Mr. Fiske when he was nineteen years old: the object of reprinting which now it is hard to see. Yet it is interesting read in immediate juxtaposition with the chapters on Darwinism, for nothing could show so distinctly how high and dry the stream of knowledge has left the whole theory of a work most celebrated only twenty years ago. Buckle's book, the theorem of which was that there is a science of history, the laws of which are as uniform and invariable as those of mechanics or astronomy, if only we could discover and measure all the various forces at work, was an energetic effort in the right direction, and was gladly welcomed by many scientific men of the day. But the key to the puzzle had not then been found. Had Buckle lived in these days, when the works of Darwin, Herbert Spencer, and Sir H. Maine are familiar, he would, no doubt, have built up a far more coherent theory than he did.

In two other papers in this volume we find development working in two very different spheres, viz., in the production of a nation, in the account of "The Races of the Danube," and in the production of a catalogue, in his description of a "Librarian's Work." Had Mr. Fiske

carried out the former more in the spirit of Buckle and Darwin, it would have added greatly to the interest of the paper and to the coherency of the book. There is also a fairly contemptuous article on "Psychic" force and its manifestations, as described by those who believe in it. His "Crumb for the Symposium" is certainly a dry one; his arguments throw no light on a very dark subject; but he draws an agreeable contrast between ten disputants on the subject of a future life meeting in the sixteenth century, and adjourning to some ecclesiastical court preparatory to a final settlement at Smithfield, with their now forming a symposium for a fair discussion in *The Nineteenth Century*.

Scattered through the book are many eloquent passages of scientific teaching. There is a striking description (p. 18) of the changes the surface of the earth has undergone, which might have prompted Byron's lines on the changelessness of the ocean. One cannot but expect good teaching from a man who lays down the excellent rules and takes the high standard of both learning and teaching truth which Mr. Fiske does, in his affectionate notice of Mr. Chauncey Wright, an eminent specimen of a class of men who, though little thought of and almost unknown individually, are yet the "good belly" which absorbs and distributes all the fresh acquisitions of more active and enterprising "members" of society. And the most valuable habit of mind in such persons is the kind of scepticism recommended by Mr. Buckle, though Mr. Fiske hardly seems to comprehend the feeling, which consists in distrusting received opinions as final; not in refusing to hold any opinions at all, but in being ready to doubt as soon as any good reason is offered. A theory, like a fire, is a very good servant but a very bad master, and true scepticism consists in willingness to give up a theory as soon as facts are brought out with which it is inconsistent. Mr. Fiske praises this high quality in Darwin (p. 34), but in other passages in his book it would appear that he urged a spirit of doubting old axioms only. He seems to think it right to put full faith in a newly-formed opinion, and to "repose" upon it (p. 175). One would have thought that the severe criticisms in his larger work, on Comte's premature conclusions, would have led him to be less confident in scientific "truths," and it is curious to see the spirit that ruled Mr. Chauncey Wright praised by a man who has confidently laid down a cosmic philosophy. Still the harm is not in airing cosmic theories—there are many valuable advantages in doing that—but in clinging to them, as human weakness is only too apt to do when they are no longer consistent with latest observations.

OUR BOOK SHELF

A Ministry of Health, and other Addresses. By B. W. Richardson, M.D., F.R.S. (London: Chatto and Windus, 1879.)

THIS is a collection of addresses given by Dr. Richardson, mostly in his capacity of propagandist of sound ideas as to individual and especially national health. In the lecture which gives the title to the volume he advocates the national urgency for a responsible minister of health, not so much to obtain new sanitary laws as to enforce the multitude of existing laws on the subject, which, from the want of any central authority, are at present a dead letter. Dr. Richardson's arguments are forcible, and must be convincing to any unprejudiced mind, and we trust that ere long his recommendations will be given practical effect to. The second paper is a sympathetic and extremely interesting sketch of the life and work of William Harvey, the model physician, teacher, and public man of his time. The other lectures are: "A Homily Clerico-Medical," "Learning and Health" (in which some valuable hints as to educational methods are given), "Vitality, Individual and National," "The World of Physic," "Burial, Embalming, and Cremation," "Registration of Disease," "Ether-Drinking, and Extra-Alcoholic Intoxication."

Frozen Asia: a Sketch of Modern Siberia. By C. H. Eden. (London: S.P.C.K.)

MR. EDEN has collected in this neat little volume a good deal of valuable information concerning Siberia. The information, however, is somewhat fragmentary in its nature, and not well digested in parts, long quotations from books and journals and daily papers being indulged in. Mr. Eden, in his account of recent explorations, confines himself to a few voyages (mainly Nordenskjöld's) along the coast, ignoring all that has been done in the interior. He, we regret to see, makes use of that most vicious and misleading term, "Turanian," and actually talks of certain quite unrelated peoples as belonging to a mythical "Turanian Stock." The sooner the word is banished from ethnological terminology, the better for the progress of the science. The book, so far as it goes, contains much trustworthy information.

Jack's Education; or, How he Learnt Farming. By Prof. H. Tanner, F.C.S. (London: Chapman and Hall, 1879.)

PROF. TANNER has put together, in the form of a really readable story, a series of papers for the purpose of showing the manner in which the science classes and the Government Department of Art enable a youth to prepare himself for the Government Scholarships, and by a tolerably complete course of science instruction qualify him for learning any industrial occupation with a thoroughly intelligent mind. The instruction in science given in colleges is reviewed from the standpoint of practical requirement, and with special regard to such a course of study being rendered most valuable as a preparation for learning any commercial industry. The story is both instructive and interesting, and we recommend it to all interested in "technical" education.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Greenwich Meteorological Observations

THE notice of the recently published "Reduction of Greenwich Meteorological Observations," NATURE, vol. xx. p. 525, contains remarks which seem to show misconception in regard to some points of the work. On these the Astronomer-Royal has requested me to offer suitable explanation.

Some criticisms, p. 526, on the table of mean air-temperatures deduced from eye-observations (Table 125), terminate with the remark that the mean temperatures for Greenwich "remain still to be calculated." But it appears to be overlooked that a complete table of standard mean temperatures, daily and monthly, deduced from the photographic records for the twenty years, 1849 to 1868 (from twenty-four readings on each day), is to be found on p. 49 (Table 77). In forming the daily means, values for the few days on which no photographic value was available were derived from the eye-observations; the results thus completely represent the period 1849-1868, and will form

our standard of reference for air temperature until a further reduction of the photographs shall enable us to extend the period and so further improve them. The mean temperature of Greenwich, according to Table 77, is 49°·72.

The mean temperatures of Table 52 are also deduced from the photographs, without correction for omitted days; they serve to show the climatic variations in different years: if desired, the effect of the omitted days could be readily determined. Here the mean temperature comes out 49°·69.

The table of mean air-temperatures for the period 1847-1873, deduced from eye-observations (Table 125), to which particular attention is drawn, p. 526, is naturally of secondary importance, and really owes its introduction into the volume partly to accident. It was thought desirable in preparing for press the deductions from the photographic records, to add, in the same volume, but in a separate section, a collection of results of the observations of the earth-thermometers for the period 1847-1873, and a table showing the mean air-temperature during the same period seemed a proper accompaniment to these results. Now the photographs had been discussed only for the period 1849-1868, and, as there were already existing mean temperatures for the longer period, 1847-73, deduced from eye observations (by use of Mr. Glaisher's corrections), these temperatures were taken for comparison with the earth-thermometer results. The expression "accurate mean temperatures" (last line of extract, p. 526) was never intended to indicate that Table 125 should supersede Tables 52 and 77, but simply to explain that the air temperatures were *mean* temperatures as distinguished from the *noon* temperatures of the remaining tables of the section. Further it is indicated in a sentence not quoted, but forming portion of the paragraph from which the extract already referred to is taken, that the eye observation series was adopted for this section because photographic results were not available for the whole period. It may be here explained that employment, for reduction of the eye-observations, of the corrections for diurnal range, &c., given by the photographic records, produces values in harmony with the photographic values, and corrections so derived are now used in the reduction of eye-observations for immediate use. But Table 125, as it stood, fulfilled the object for which it was inserted, that object being rather to exhibit *variations* of temperature. No argument founded on the absolute temperatures shown by the earth-thermometers has much significance, because we are unable to test their index errors. In fact, the true value of the whole collection of tables in the earth-temperature section consists, not on their exact indication of absolute temperature, but on the information which they afford in regard to comparative changes of temperature, the retardation of temperature, and generally the propagation downwards of surface-waves of temperature.

In the last paragraph of the notice attention is directed to what is called the "somewhat rough method" adopted in reducing the barometric observations to 32°. This erroneous idea may have, perhaps, been encouraged by the circumstance that in the Introduction no mention appears to have been made of the fact that the temperature of the underground apartment in which the photographic barometer is placed is almost uniform. Considering this in connection with the construction of the apparatus, in which (as fully explained in the Introduction) the register depends on the height of the mercury in the lower tube of a syphon barometer, and is influenced by the expansion of some four inches only of the mercurial column, it will be understood that the effect of temperature (change of temperature) in a period of twenty-four hours (the extent of one sheet) is not perceptible.

In the third and fourth lines of the paragraph, on p. 526, commencing "From this table," it would seem that the word "excess" should be "defect." WILLIAM ELLIS

Royal Observatory, Greenwich, October 7

Saturn's Dusky Ring

I WRITE to call the attention of observers to the present appearance of the inner dusky ring of Saturn. Although the ring is not very open, only permitting that portion near the ends to be seen on the nights of the 9th and 11th of this month, using a portion of a large reflector sufficient only to show Enceladus clearly, it was most prominent, and not to be overlooked. It had the appearance of being covered with bright points, such as a rough dusk paper touched lightly with chalk would give; that part in front of the ball being dark, and showing as a fine dark line across, equal in width and shade to the shadow beneath, so that the narrow part of the whole ring appeared on the face of the planet as if bounded by two fine parallel dark lines. The wide and the narrow division at the ends of the ring were very plain.

Not having seen this dusky ring before, I can only go by the published accounts, but it is so much brighter than they would lead one to suppose that it is very difficult to believe that it is not changing very rapidly. The observation of one to whom the ring is familiar would settle this point. A. A. COMMON

Ealing, October 13

Suicide of the Scorpion

DOUBTS having been expressed at various times, even by learned naturalists, as to the reality of the suicide or self-destruction of the scorpion by means of its own poison, and these doubts having been again stated in NATURE, vol. xx. p. 553, by Mr. R. F. Hutchinson, of Peshawar, as the result of his own observations, I think it may be useful to give an articulate account of the phenomenon as it has been related to me by an eye-witness, which removes all possible doubt as to its occurrence in certain circumstances.

While residing many years ago during the summer months at the baths of Lucca, in Italy, in a somewhat damp locality, my informant, together with the rest of the family, was much annoyed by the frequent intrusion of small black scorpions into the house, and their being secreted among the bedclothes, in shoes, and in other articles of dress. It thus became necessary to be constantly on the watch for these troublesome creatures, and to take means for their removal and destruction. Having been informed by the natives of the place that the scorpion would destroy itself if exposed to a sudden light, my informant and her friends soon became adepts in catching the scorpions and disposing of them in the manner suggested. This consisted in confining the animal under an inverted drinking-glass or tumbler, below which a card was inserted when the capture was made, and then, waiting till dark, suddenly bringing the light of a candle near to the glass in which the animal was confined. No sooner was this done than the scorpion invariably showed signs of great excitement, running round and round the interior of the tumbler with reckless velocity for a number of times. This state having lasted for a minute or more, the animal suddenly became quiet, and turning its tail or the hinder part of its body over its back, brought its recurved sting down upon the middle of the head, and piercing it forcibly, in a few seconds became quite motionless, and, in fact, quite dead. This observation was repeated very frequently; in truth, it was adopted as the best plan of getting rid of the animals, and the young people were in the habit of handling the scorpions with impunity immediately after they were so killed, and of preserving many of them as curiosities.

In this narrative the following circumstances are worthy of attention:—(1) the effect of light in producing the excitement amounting to despair which causes the animal to commit self-destruction; (2) the suddenness of the operation of the poison, which is probably inserted by the puncture of the head into the upper cerebral ganglion; and (3) the completeness of the fatal symptoms at once induced.

I am aware that the phenomena now described have been observed by others, and they appear to have been familiarly known to the inhabitants of the district in which the animals are found. Sufficient confirmation of the facts is also to be found in the narratives of G. Biddie and "M. L." contained in NATURE, vol. xi. pp. 29, 47, and it will be observed that the circumstances leading the animal to self-destruction in these instances were somewhat similar to those narrated by my informant. It is abundantly clear, therefore, that the view taken by Mr. Hutchinson, viz., that the "popular idea regarding scorpionic suicide is a delusion based on an impossibility" is wholly untenable; and indeed, the recurved direction of the sting, which he refers to as creating the impossibility of the animal destroying itself, actually facilitates the operation of inflicting the wound. I suppose Mr. Hutchinson, arguing from the analogy of bees or wasps, imagined that the sting would be bent forwards upon the body, whereas the wound of the scorpion is invariably inflicted by a recurvation of the tail over the back of the animal. ALLEN THOMSON

London, October 11

Climatic Effects of the Present Eccentricity

I ASK for an explanation of the following difficulty:—

Dr. Croll says, in his "Climate and Time" (p. 65), that "the

temperature of a place, other things being equal, is proportional to the heat received from the sun."

His reviewer in the *Quarterly* for July last says: "The mean January temperature of England may be taken at 39° F., which is equivalent to 278° F. of absolute temperature" (meaning, above the temperature of space taken at −239° F.), "and if we calculate what would be the mean temperature of the same month when the sun was distant 97,500,000 instead of 91,000,000 of miles as it is now, we find it comes out 242° F., which is equivalent to 3° F. of our thermometer, or 29° of frost."

If we use the same method to find to what extent the present value of the eccentricity ought, even now, to affect temperatures on the earth's surface, we arrive at a result apparently so contrary to experience that I think "there must be a mistake somewhere." I ask your readers to tell me where.

Let S be the temperature of space. Choose two places in equal north and south latitude; and let U, U' be their July temperatures respectively, A, A', their January temperatures, *i.e.*, at aphelion and perihelion; e the eccentricity. Then we have, according to the principle used by Mr. Croll and his reviewer—

$$\frac{S + A'}{S + U} = \left(\frac{1 + e}{1 - e}\right)^2.$$

With the present value of the eccentricity, viz., 0·0168, this gives—

$$A' = 0·0695\, S + 1·0695\, U,$$

giving to S the usually accepted value, −239° F.

$$A' = 16·61 + 1·0695\, U.$$

$$\therefore A' - U = 16°·61 + 0·0695\, U \quad . \quad . \quad . \quad (1)$$

That is to say, the January temperature of the place in south latitude, ought to exceed the July temperature of the place in equal north latitude by more than 17° F.

In like manner we find the relation between U' and A to be—

$$U' - A = -15°·53 - 0·07\, A \quad . \quad . \quad . \quad (2)$$

That is to say, the July temperature of the place in south latitude ought to be more than 16° lower than the January temperature of the place in north latitude.

Now it may be replied that geographical and meteorological causes may completely mask these differences. The mean June temperature of the northern hemisphere is known to be higher, instead of lower, than the mean December temperature of the southern hemisphere, and it is considered that this is sufficiently accounted for by the excess of land there. If this explanation be true, the effect of the excess of land must be capable of increasing the mean temperature not only by the number of degrees by which the northern hemisphere exceeds the southern, but by this amount *plus* 17° F.

Subtracting (2) from (1)—

$$(A' - U') - (U - A) = 32°·14 + 0·07\, A + 0·069\, U.$$

This shows that, so long as A' is greater than U' and U greater than A, this difference is greater than 32°. That is, the difference between the excess of summer temperature over winter in the southern hemisphere exceeds the like excess in the same latitude north by more than 32°. Is there any indication of an excess of annual variation in anything like this extent in the southern hemisphere?

But observe the result at the equator. If the latitudes of the two places are continually diminished they will eventually be found both of them on the equator; in which case A' and A become identical, and likewise U' and U. Now the right-hand side of the equation being positive, the left-hand side must be so too. Hence $-(U - A)$, which was negative, in becoming $A' - U'$, which is positive, must pass through zero. This shows that one effect of the eccentricity is that it is not under the equator that the January and July temperatures are the same, but under some latitude north of the equator.

When the two places are both on the equator, or rather when only one place upon the equator is considered,

$$A - U = 16·07 + 0·03\,(A + U) \text{ (nearly).}$$

If we put for $\frac{1}{2}(A + U)$ the mean temperature of the equator, or 80° F., this equation gives $A - U = 21°$. F. nearly.

That is to say, the January temperature of a place on the equator ought at the present time to be about 21° F. higher than the July temperature, if the temperature of space is so low as −239° F.

The temperatures themselves would be—

$$A = 90°\tfrac{1}{2},\ U = 69°\tfrac{1}{2}.$$

I would ask, therefore, whether there is any indication of so great a difference as the above at any station on or close to the equator.

If $A - U$ is not so great as 21° F., it must be owing to causes which diminish A or increase U. The place being on the equator, would not be reached by the north-east trade-winds; moreover, in July their extension towards the equator would be least. Consequently, they would have little effect to increase U by bringing warmth from the heated continents. In a similar way the south-east trades would be at their weakest in January, and have their least effect to diminish A by bringing cold air and water from the Southern Ocean. Meteorological causes would, therefore, seem to tend rather to exaggerate than to mask the difference in question, if the observations were taken in an insular position near the equator.

I believe there is admitted to be some uncertainty about the value used for the temperature of space. Herschel's investigation in his meteorology may not be thought satisfactory. But it is remarkable that Pouillet, following quite a different method, arrived at almost the same result. At any rate the temperature which the earth would assume, were the sun extinguished, must be very low. But is it so low as −239° F.? If it were, it appears that, if the principle used be correct, those results would follow which I have suggested; and I ask whether any observations bear upon the question? It is obvious that it touches Dr. Croll's celebrated theory somewhat closely. O. FISHER

Harlton, Cambridge, October 4

Does Sargassum Vegetate in the Open Sea?

HAVING had many opportunities of observing patches of "living Sargassum in the open sea" from the deck of H.M.S. *Challenger* during her cruise in the North Atlantic in the early part of the year 1873, I venture to offer a few remarks in reply to the above inquiry of your correspondent in NATURE, vol. xx. p. 552. The track of our ship between Madeira, the Canary Islands, St. Thomas in the West Indies, Bermudas, and the Azores is almost equivalent, as a glance at the map will show, to a complete circumnavigation of the central part of the North Atlantic generally known as the Sargasso Sea. During this cruise *Sargassum bacciferum* was met with frequently so as to render the appearance of this seaweed a sight quite familiar to all on board the *Challenger*. It was first seen on March 2 in about lat. 22° 30′ N., long. 42° W., halfway between the Canaries and the West Indies. Again on March 6, lat. 21° N., long. 49° W., quantities of gulf-weed drifted past the ship. On more than one occasion large patches of Sargassum were observed extending from the vicinity of the vessel to a great distance. The gulf-weed was also encountered between St. Thomas and the Bermudas group, and was last met by us between the latter islands and the Azores on June 18, lat. 35° N., long. 53° W.

As regards the exact form and appearance of this interesting alga, I cannot do better than quote from the graphic description given by Sir C. Wyville Thomson in the pages of "The Atlantic," vol. ii. pp. 9, 10:—

"They (the patches) consist of a single layer of feathery bunches of the weed (*Sargassum bacciferum*), not matted but floating nearly free of one another, only sufficiently entangled for the mass to keep together. Each tuft has a central brown thread-like branching stem studded with round air-vesicles on short stalks, most of those near the centre dead, and coated with a beautiful netted white polyzoön. After a time vesicles so encrusted break off, and where there is much gulf-weed the sea is studded with these little separate white balls. A short way from the centre, towards the ends of the branches, the serrated willow-like leaves of the plant begin; at first brown and rigid, but becoming farther on in the branch paler, more delicate, and more active in their vitality. The young fresh leaves and air-vesicles are usually ornamented with the stalked vases of a *Campanularia*. The general colour of the mass of weed is thus olive in all its shades, but the golden olive of the young and growing branches greatly predominates. The general effect of a number of such fields and patches of weed, in abrupt and yet most harmonious contrast with the lanes of intense indigo which separate them, is very pleasing."[1] On p. 339 of the same volume we find the following remark:—"Very few of the higher algæ live even occasionally on the surface of the sea; the notable exception is the gulf-weed

[1] "The Atlantic," by Sir C. Wyville Thomson. (London: Macmillan and Co., 1877.)

(*Sargassum bacciferum*), which scatters its feathery islets over vast areas of warm, still water; and affords rest and shelter to the peculiar nomadic fauna to which I have already alluded (vol. i. p. 186, &c.)."

My colleague on board the *Challenger*, Mr. H. N. Moseley, on p. 567 of his recently-published "Notes by a Naturalist,"[1] refers to the pelagic habits of Sargassum and other sea-weeds in the following words:—

"Besides these smaller algæ (*Trichodesmium*) living in the open ocean, there are abundance of several species of larger sea-weeds which are pelagic in habit. The Gulf-weed, *Sargassum bacciferum*, of the Sargasso Sea in the Atlantic, is well known. It is brown when dried or preserved, but when living is of a very bright yellow colour, which contrasts pleasingly with the deep blue of the open Atlantic. Another sea-weed (*Fucus vesiculosus*) is to be found also living free in the Atlantic, and the Giant Kelp (*Macrocystis pirifera*), in the floating condition, ranges over a wide belt of the Southern Ocean, as proved by Sir Joseph Hooker ('Flora Antarctica,' vol. i., pp. 464-465).

"All these sea-weeds grow attached to rocks on various shores as well as free, but they all produce spores, only when attached. The pelagic varieties multiply only by simple growth and subdivision. A wide area covered with sea-weeds corresponding to the Sargasso Sea occurs in the North Pacific Ocean."

In refutation of one of the fanciful reports alluded to by your correspondent, namely, that some branches of the floating Sargassum rise two inches above water, and are thus driven along by the wind, I may add that the bunches of the Gulf-weed float at, but not upon, the sea-surface, being almost completely immersed in the water, and often entirely so. At times, when a patch of weed is seen crowning the top of a wave, the tips of the feathery bundles protrude above the water, without, however, presenting a surface large enough for the wind to act upon. Probably, owing to the action of surface-currents, an apparently endless procession of patches, large and small, may be often observed drifting past the ship, forming in the aggregate long yellow streaks or bands, which cover the sea as far as the eye can reach.

J. J. WILD

The Temple of Nodens in Lydney Park

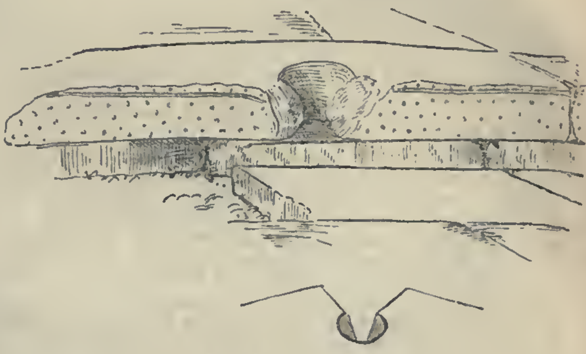
PROF. RHŶS' interesting review on Mr. King's volume in NATURE, vol. xx. p. 285, has been recalled to mind by the notice of the same quarto in Saturday's *Athenæum* (September 27); and I would remind those interested of the occurrence of a somewhat analogous relic of ancient rites in the pavement of the primæval fane on the island of Gozo; which relic was first (I believe) noticed by myself in the pages of the *Athenæum* in November, 1872. A fuller account, with diagrams of the pavement, appeared subsequently in the *Journal* of the Anthropological Institute, vol. iv. (Plate vi.) in a paper on the "Non-historic Stone Relics of the Mediterranean."

Prof. Rhŷs writes: "We have not yet done with the pavement, for in the part occupied by the dedicatory inscription, but not quite in the centre, seemingly not to cut up the names, as Mr. King thinks, there is what he describes as 'a circular opening, nine inches in diameter, surrounded by a broad red band again inclosed in two others of blue.' That some high mystery was involved in the setting of this unsightly object in so conspicuous a position, cannot admit of any doubt." He comes to the conclusion that this funnel was meant to receive libations poured to the god, and that they were drunk up by the dry soil beneath. He further compares this opening in the pavement "to the well of salt water, that famous memorial of the former presence of Poseidon in the Acropolis of Athens."

Compare this with my account of the Gozo pavement in 1872, as follows:—

"In the pavement of the inner left-hand pair of chambers at Gozo, to the right are the partially-covered remains of a large stone basin, or hollowed stone with a broad raised brim, and in the threshold of the entrance, between the two chambers, a broken holed stone, at the base of which was some coarse burnt clay, hollowed so that the stone could hold water. At Hagiar Khem these holed stones or stone rings are frequent, and may have been used for holding the pins on which the valves of heavy doors turned, or, more probably, may have served to support earthenware *amphoræ* or *cadi*, with pointed bases, as was commonly the practice amongst not only the ancient Egyptians, but also the Greeks and Romans.

"The most unaccountable feature, however, in the whole of the monuments is to be found in the central stone of the platform of the centre apse at Gozo, right opposite to the entrance of the left-hand pair of chambers. This consists in a curious *funnel-shaped*



concavity, with one side cut away to the edge of the step of the platform of which it forms part. It is sharply cut, and in tolerable preservation, and seems designed as a species of socket in which some portable pillar, pole, altar, or vase could be fitted and fixed, or unshipped and replaced, on separate occasions. The reader may suggest some more practical use for which it may have been intended."

Accordingly, I would now adopt Mr. King's suggestion that, like the terra-cotta funnel fitted into the similar orifice at Lydney, it was meant to receive the drink-offerings of blood or libations of wine poured to the "god of the deeps." Anyhow, this would add effect to the surmise that a primæval fane of huge stones (very doubtfully *Druidical*! may I suggest *Phœnician?*) had been converted into a Roman temple for the benefit of the Latin-speaking iron-workers, "*prope Sabrinum ostium*." The *Athenæum* reviewer reminds Mr. King that there is no *classical* authority that connects Druidism directly or indirectly with any stone temple or megalithic remains, adding, however: "*The dolmens of Wales are probably posterior to the withdrawal of the Romans.*" What authority can he claim for this except Mr. Fergusson's Arthurian myths from the Welsh triads in Herbert's "Cyclops Christianus." I should be glad if Prof. Rhŷs would deal with this question, and ask if he can reconcile the following theories of Fergusson in his "Rude Stone Monuments":—

1. The post-Roman dolmen-builders came "from the south, first touched in Cornwall, and thence spread northwards, settling on both sides of St. George's Channel, and leaving traces of their existence on the south and both coasts of Ireland, as well as in Wales and the west of England generally" (see p. 274).

2. The Siluri and Brigantes emigrated from Spain to the banks of the Severn 261 years before our era (p. 381).

3. "We find the Bryts beginning to use stones after having been driven from the fertile plains of the east into the fastnesses of Cumberland and Wales; so we find the Spaniards first adopting rude stone monuments after having been driven into Portugal and the Asturias" (p. 380).

4. Locqmariaker and the monuments of the River Boyne were all erected in the first four centuries after Christ (p. 370).

5. The Crozon and Carnac monuments ascribed to the Arthurian age, 380–550 A.D. (p. 375).

6. The dolmen of Confolens: "It is a dolmen pure and simple, and it was erected in the twelfth century" (p. 336).

The Phœnicians, who dealt with the tin-workers of Cornwall, must have been amongst the first navigators who explored the banks of the Severn and recognised the mineral treasures of the Forest of Dean.

S. P. OLIVER

P.S.—Since writing the above I notice that M. Carapanos and M. Foucart found certain lead plates from the ruins of Taracovista (the ancient Dodona), on which petitions similar to that of Silulanus are inscribed; for instance, one Agis consults the great Zeus on the subject of his pillows and blankets, which he has lost or had stolen from him; whilst another, a shepherd promises his gratitude to Zeus if he succeeds in rearing his sheep, &c. These tablets and bronzes found with them were exhibited at Paris last year. The great Dodonian Zeus therefore

[1] "Notes by a Naturalist on the *Challenger*," by H. N. Moseley, M.A., F.R.S. (London: Macmillan and Co., 1879.)

may have been the prototype of the Silurian *Nodons*. What is the orthography of Lydney? S. P. O.

October 5

Do Bacteria or their Germs exist in the Organs of Living Healthy Animals?

IN the August number of the *Journal für praktische Chemie*, Messrs. Nencki and Giacosa assert that bacteria and their germs exist in the organs of healthy living animals, in contradiction of Messrs. Chiene and Ewart, who took the negative side of this question in the *Journal of Anatomy and Physiology* for April, 1878. I give the chief parts and points of Nencki and Giacosa's refutation.

"Dr. Burdon Saunderson repeated Tiegel's experiments. The organ just taken from a newly-killed animal was immediately plunged into paraffin heated to 110°. As soon as the mass cooled the surface was covered with Venetian turpentine, so as to protect the specimen from infection from without by the cracking of the paraffin. Burdon Saunderson announces that when two days after, the organ at the bottom of the vessel was taken out, it was in a clotted and rather cooked condition on the outside in consequence of the heat. But the centre contained numbers of bacteria in the various stages of their existence. . . . The last-named authors (Chiene and Ewart) worked upon the conclusion that in the time between extracting the organ and plunging it into the paraffin, bacteria germs from the air fall upon it, thus causing the subsequent decomposition. This was to be guarded against by an antiseptic method. Their procedure, therefore, was as follows:—Under a continuous spray of a solution of carbolic acid, a newly killed rabbit's abdomen was opened, and the liver, spleen, kidneys, and pancreas extracted. The liver was cut into several pieces; some pieces were wrapped in gauze, soaked in a solution of carbolic acid. Others were wrapped in unprepared gauze; while others were put into jars which were raised to a great heat, and then closed up with wool, gauze, or glass covers. The same was done with the other organs. After three days, the specimens were examined, and no bacteria were found in those which had been wrapped in antiseptic gauze. . . . Messrs. Chiene and Ewart therefore conclude that if the organs are treated antiseptically after death, no bacteria or germs of them will be found; and that hence no germs of bacteria exist in the living, healthy organs. . . ." Messrs. Nencki and Giacosa thus describe an experiment which they made, in order to prove the contrary. There was a vessel containing mercury; a large glass test-tube, filled with mercury, closed with a slip of glass, and inverted in the vessel. The latter was then heated till the tube was one-third filled with mercury vapour, which must have destroyed any bacteria which could by any possibility have remained in it. The vessel was allowed to cool; the quicksilver in the tube condensed again; and when the mercury in the outer jar was at 120°, it was covered with a 5 per cent. solution of carbolic acid." Some internal organ (liver, heart, kidneys, or spleen) was then taken from a rabbit that had just been killed, and with a pair of tweezers was brought under the mouth of the tube, up which it ascended when let go. The apparatus was then kept at a temperature of 40° for several days. The results of all experiments conducted in this way were favourable to the admission that bacteria exist in the organs of living healthy animals. Already in twenty-four hours all the organs, when examined, gave out an intensely foul odour, and showed countless split fungi in different forms. . . . The beginning of putrefaction is shown by the pressing down of the mercury in the tube by the generation of gases. . . . All the vessels and instruments we employed were lifted out, immediately before use, from a carbolic acid solution. . . . Why, then, did putrefaction not set in in Messrs. Chiene and Ewart's experiments? That neither a spray of, nor transient immersion in, carbolic acid will kill the germs in the tissues, is proved by our experiment, in which the organ is passed through the solution into the mercury and up the tube. But it is a different thing when the organ is for a long time in contact with material (the antiseptic gauze) previously soaked in the solution of carbolic acid." This, Nencki and Giacosa prove by experiment. And it seems to be natural that while a brief immersion in the antiseptic solution must be amply sufficient to destroy any bacteria which might have lodged upon the organ in its transit through the atmosphere, prolonged contact with the solution must cause the inmost parts of the specimen to be permeated by the destroying poison, thus rendering the results of the subsequent examination null and void in their bearing on the question. In conclusion, Messrs. Nencki and Giacosa maintain that pathologists must accept the fact that the germs of bacteria exist in the organs of living healthy animals, and advise them to consider this in their studies of infectious diseases, as the existence of ordinary decomposition bacteria in the tissues indicates that it may be different forms of them which are the causes of various contagious maladies. E. BURKE, jun.

Subject-Indexes to Transactions of Learned Bodies

MR. GARNETT, in his paper printed in NATURE, vol. xx. p. 554, proposes to make the Index to Scientific Periodicals by cutting up two copies of the Royal Society's Catalogue and using this as the "copy" for the Index; but the thought has struck me that if the "copy" of the Royal Society's Catalogue is still in existence there is the material ready to hand for commencing work at once. I believe the Index might be done this way by any one who had access to the chief periodicals; but the title of a paper is often so very deceptive that without frequent reference to the papers themselves I am afraid we should get even worse mistakes than the one mentioned by Mr. Garnett. Now that the last volume of the Catalogue is out it is sincerely to be hoped that the Council of the Royal Society will take this "Subject-Index" into consideration. JAS. B. BAILEY

October 10

Change of Colour in Frogs

IT is certainly a common opinion in this part of the country that when frogs become of a bright yellow colour fine weather may be expected. The brightness of colour can scarcely be due to the presence of sunlight, for frogs of a bright yellow may frequently be found in cellars, wells, and other dark places. Throughout the past summer and up to the present time, I have noticed that the frogs in this neighbourhood have been of an extraordinarily brilliant yellow tint. Again and again have I heard the country people, working in the hay or corn fields, under the unbroken canopy of cloud, remark—"We must be going to have fine weather now, for look at the colour of the frogs." These forecasts proved the reverse of successful.

W. CLEMENT LEY

Ashby Parva, Lutterworth, October 10

AT the commencement of "the rains" (say, beginning of June), in the island of Bombay, after the first showers, when a little water lodges in the depressions of the old-quarry tanks, the frogs issue from the crevices of the trap-rock to spawn, when the *males* (some of which are 18 inches in length from tip of toe to end of digit) assume a bright mustard-yellow colour, while the females remain brown as usual; and this change of colour takes place so rapidly, and the frogs are so numerous, that, with the falling of the showers, the bottom of the quarry becomes suddenly yellow. I never saw a frog so coloured at any other time, and I witnessed the fact above mentioned for at least two successive seasons in the same old quarry. H. J. CARTER

Devon, October 13

Intellect in Brutes

THE case of the Norwegian dog, Nero, mentioned by Mr. Horsfall in NATURE, vol. xx. p. 505, is certainly an admirable example of abstract reasoning. Here the dog thought as any man would have thought how, where, and when to catch the railway train suited to his purpose. It has reminded me that, when I was in Malta a few years ago, a fine Newfoundland dog (if I remember correctly) used to accompany Miss Hallett in her ride from Sliema to Valetta on a visit to her grandfather in Strada Forni. The ride is about four miles round the head of the harbour. On one occasion she observed that the dog had ceased to follow her, and concluded that, owing to the heat or some other cause, it had returned home. Her surprise was considerable on arriving in Strada Forni, for there she found the dog waiting for her at her grandfather's door. The explanation is, as was subsequently discovered by a frequent repetition of the same thoughtful dodge: the dog had gone to the ferry, waited there until passengers stepped into the boat, got in himself, was ferried across the harbour, and in this way was saved a long and, it may be, a hot and a dusty run. So far as I can remember, the animal had no previous experience of this short

mode of transit between Sliema and Valetta, except that he had *observed* people performing the journey by that route.

One of your correspondents some time ago gave as an instance of sagacity the case of a monkey returning to him a nut for the obvious purpose of having it cracked. It recalled to me that, several years since, I gave a nut to a monkey in the Zoological Gardens, London, whereupon the said monkey, having put the nut into his mouth and moved his jaws about with a sort of theatrical effect indicative of the hardness of the shell, returned it to me, as any child might have done under similar circumstances, with the evident object of getting me to crack it. I declined, and, at the same time, I gave back the nut. The monkey descended to the ground, laid the nut down, picked up a stone, and at once cracked it for himself, showing an intelligent idea of resources, that as my teeth were not available as a substitute for his, he could utilise a stone for a hammer.

CHAS. POPHAM MILES

Château de St. Léger, Darnétal, Seine Inférieure, October 7

Butterfly Swarms

INCLOSED is a specimen of butterfly which, about the middle of December, 1878, flew past my bungalow in crowds, all making for north-west, and going down-hill. In about four weeks afterwards, that is, well into January, 1879, the same butterfly began to return, this time flying to south-east, and uphill. Starting from the bungalow, I rode four miles to northwest, and went about 1,000 feet down-hill, and found the butterfles still ascending. They came from beyond a hill about 300 feet higher than the bungalow, and they went back over the same range.

On both occasions the temperature stood at about 80° F. in the shade, the winds moderate and variable, and as often against as in favour of the flight, which, on its going and coming, lasted for two to three days both ways.

On the return journey I found the butterflies settled in "swarms" on damp, sandy spots near ravines, and so thickly settled that with one sweep of a circular butterfly net fifteen inches in diameter I caught about 150.

M. B.

Hill Country of Ceylon, 3,000 feet above Sea-level, September 14

[The butterfly is one of the *Pieridæ*, and in all probability is identical with *Appias albina*, Boisduval. The habit of settling in swarms on damp spots is common to many butterflies, and even to several of the few species that occur in Britain.—ED.]

The Hunting Spider

THIS arachnid is very common out here, a very tiger amongst insects, and very interesting to watch. Its poison must be intensely virulent. If two are placed together under a finger bowl, and one happens to be the smaller, a very little manœuvring soon brings him within the instantaneously fatal grip of the larger animal; but if of equal size, a most interesting series of watchful movements and counter movements commences, each anxious to secure the first and fatal bite. Leap after leap is parried, advance of one is accompanied by a wide awake backward retreat of the other, and so on for a long time. When *the* fatal spring is made, the victim is at once *hors de combat*, and the conqueror carries it off rejoicingly. I once gave a spider a blue-bottle fly, and then learned for the first time that these insects were viviparous, for the fly in its death throes protruded a heap of active little maggots which soon died from want of a proper nidus in which to develop. On another occasion I found a hunting spider on a looking glass, and as from its movements it was evidently after game, I drew near quietly to watch. To my surprise and amusement I found that the spider was *stalking its own reflection*, and its cautious movements on tip toe, looking downwards, opened up to me a wide field of thought. What feeling was at work in that small breast? Was it the natural instinct after prey, or the burnings of jealousy in the apparent presence of a rival, or pleasure in scrutinising its own charms, now for the first time exhibited to it? If the latter, then the hunting spider is, I fancy, the lowest animal in the scale, which has been deceived or flattered by a looking glass.

Dogs, monkeys, and cats, are easily imposed on by a glass, and, as the first thing a monkey does on seeing a mirror, is to pass its hand round to the other monkey, you can soon originate a fight by grasping the hand behind the glass; and then hastily dropping it, watch the amazement of Jacko at the sudden and mysterious disappearance of his rival.

Peshawar

H. F. HUTCHINSON

GEOGRAPHICAL NOTES

ON Saturday evening the Berlin Geographical Society, presided over by Dr. Nachtigal, celebrated the birthday anniversary of Carl Ritter, the famous German geographer—a ceremony which had been postponed from August. Ritter himself founded this society in 1828, and presided over it till 1860. "Those days," said Dr. Nachtigal, in opening the proceedings, "on which their intellectual princes are presented to the nations are landmarks of their life and development, and to honour them is a duty of honour." The University, the Army, and the other kindred societies throughout Germany, were all largely represented, and handsome subscriptions were announced for a memorial to the hero of the evening.

AMONGST the resolutions passed at the Brussels International Congress for Commercial Geography we point out the following:—1. The Congress is of opinion that, in the interest of all nations it is desirable that one or more lines of railway should connect the coasts of Afric with its interior. 2. Complete freedom of trade should reign there. 3. In the expectation of a complete abolition of custom-houses, it is desirable that as many commercial treaties as possible should be concluded. It is particularly necessary that a treaty of this kind should be preliminarily entered into between Belgium and Holland. 4. The Congress expresses the wish that everywhere instruction in history should be separate from that in geography. The Congress expressed some further wishes which related to an expedition for discovering the shortest route from Mandalay to Mekong; the speedy execution of the Panama Canal project, the rendering safe of the commercial routes leading to Inner Africa, the furtherance of free trade, the amelioration of the system of representation of countries by consuls, the commercial route from Tong King to the south-west of China, the introduction of the same meridian for all countries, the construction of railways on the Balkan peninsula and in Asia Minor, the introduction of a uniform system of measures, weights, and moneys for all civilised peoples, the abolition of slavery in countries where it continues to be officially countenanced. Next year's congress will take place at Lisbon.

AN International Geographical Congress will be held at Nancy in August, 1880.

THE International Congress of Americanists was opened at Brussels on September 23. The King of the Belgians and many persons of rank were present.

THE boundary between British Guiana and Venezuela is a very vexed question, and in consequence of Mr. Boddam-Whetham having included in his recent work some notes on it from a Venezuelan source, Mr. E. F. im Thurn, a well-known authority on matters relating to British Guiana, has gone carefully into the matter. He has just embodied the results of his investigations in a little *brochure*, which contains a good deal of geographical information. Mr. im Thurn regards the following as the best settlement of the question. The mouth of the Morooca should be taken as the northernmost point of our colony, and from there to the old Dutch post on the Cuyani, the boundary should be as in Cordazzi's map. Thence it should be carried to the nearest point of the Mazaruni, and then up the course of that river to the junction of the River Cako, and along the latter river to Mt. Roraima. From that central and well-marked point, southward to the source of the Corentyne, and then northward along the course of the river, it should follow the line laid down in Sir R. Schomburgk's map.

THE special service officers, whose departure for South Africa was alluded to in NATURE, vol. xx. p. 64, have evidently done good work from a geographical point of view, for in his despatch, written from Ulundi on September 3, Sir Garnet Wolseley, in reporting the conclusion of the war, states that he has been able to extend our topographical knowledge of Zululand, and by actual survey, as well as by reconnaissances, to lay down on paper with very tolerable accuracy its rivers, mountains, &c.

THE St. Petersburg correspondent of the *Daily News* telegraphs that after the departure for England of the seven steamers which failed to get through the Kara Sea, the steamship *Louisa*, with a Russian charter, succeeded in finding a passage, and arrived at Yeniseisk, discharged her cargo, and loaded 20,000 poods of wheat for Europe. The *Golos* recommends the establishment of a meteorological station at the extremity of the Island of Waigatz, between the two gulfs, to be connected by telegraph with the other parts of the Empire and Europe.

ACCORDING to the *Colonies and India*, Mr. Alex. Forrest, in his journey across North-west Australia, from De Grey River to Beagle Bay, found large tracts of rich land along nearly the whole coast and within easy reach of the sea. From Beagle Bay he went to the western shore of King's Sound, and after passing up the Fitzroy River, returned along the eastern boundary of West Australia. He reports well-watered and grass country near Beagle Bay, though it is rather densely wooded with the cajeput, red and white gum, &c. No rivers of any size were discovered, and the country was almost entirely level. As regards natural productions, Mr. Forrest reports the pearl-shell beds to be unlimited in extent. The soil is generally a sandy loam; in some parts there are a few ironstone hills, and in others limestone is found, but nowhere are there any indications of gold.

MR. ORVILLE A. DERBY, Director of Geology in the National Museum of Brazil, we learn from *Science News*, was at last accounts about starting on an exploring expedition in the interior of the empire. He goes in company with a party of engineers who are to make surveys for a railroad route. The chief of this party is Mr. Roberts, an American. They will first ascend the river São Francisco to the Falls, which are 168 miles from the sea. They carry with them a steam launch, by means of which they expect to navigate the river above the Falls. Mr. Derby expects to leave the engineers after their work is finished, and to cross the province of Minas Geraes, celebrated for its product of gold, and he will make the geology of that region a special study. The distance to be gone over is not less than 600 or 700 miles, and will probably be much more in the detours of travel. A very hasty geological survey was made of the country in 1866 by J. A. Allen, the ornithologist, O. H. St. John, geologist, and Thomas Ward; they were then members of the famous Agassiz expedition. They began in the upper waters of the river and worked downward toward the Falls. The late Prof. Hartt explored below the Falls, to the mouth of the river. The work undertaken by Mr. Derby is in an important and very extensive field, about which very little is definitely known.

THE American expedition, gone out in search of the remains of Sir John Franklin, which landed at the northern shore of Hudson's Bay, in the vicinity of Depots Land, on August 9, 1878, continued its journey to King Williams Land in sledges, on April 1, 1879.

THE German geographers, Drs. Greef and Gasser, have arrived at Lisbon on their way to Africa. A scientific task has been confided to them, and they will begin their labours with the study of the zoology of the West African Islands.

NEWS just arrived from Pekin states that the Hungarian traveller, Count Szechenyi and his companions have started on the journey to Tibet, under protection of Chinese officials, and with an escort of thirty soldiers. They intend to visit Sining, Shen-Chung-Chia, and Tsaidam, and then to proceed on the great northern Kukunor road to H'Lassa, which is situated some 700 miles beyond Tsaidam.

EARLY in the present year the Rev. C. R. Fairey made a most remarkable missionary journey, travelling alone for some 300 miles along the dangerous north and east coasts of Tasmania. The journey was entirely performed in a canoe 12 feet long, 28 inches beam, and 12 inches in depth. Mr. Fairey now proposes to make a voyage on the Murrumbidgee and Murray Rivers in Australia.

AFTER the pattern of European Alpine Clubs a Himalaya Club is stated to have been formed in India with a view of attempting to ascend the highest peaks of that gigantic mountain chain.

UNDER the title of "La Cimbébasie" *Les Missions Catholiques* publishes some interesting geographical notes on a tract of country in Western Africa, extending on the seaboard from the mouth of the River Cunene to that of the Orange River. On the north the boundary of this region, which has lately been constituted a separate ecclesiastical district by the Holy See, marches with that of the Portuguese colony of Angola in the direction of the Mano Mountains, and then follows the right banks of the Casai and the Lotenbua as far as Lake Dilolo. On the east it runs along the Liba to the point where the Chobé (the Cuando of Major Serpa Pinto) falls into the Zambesi, and finally follows the eastern frontier of the Bechuanas from Lake Makarikari to the Rivers Vaal and Orange. In this region are included Damara-land on the north-west, Namaqua-land on the south, the tribes of the Kalahari Desert on the east, and on the north Ovampo-land, &c. These notes, which are drawn up by Père Charles Duparquet and are illustrated by a map, are the more worthy of attention, as the greater part of this large tract of country has recently been placed under the British Protectorate.

SIR GEORGE ELLIOT, M.P. for North Durham, has signified his intention to dedicate a piece of land on his estate, West Cliff, Whitby, to the public, and erect thereon a monument to Capt. Cook, who spent several years of his early life at the fishing village of Staithes, a few miles to the north of the port of Whitby. In later years he sailed from the harbour of Whitby, and it is an historical fact that in undertaking his adventurous voyages round the world he preferred the vessels which were built at Whitby by Whitby men.

MESSRS. SAMPSON LOW AND CO. are to publish Dr. Holub's Narrative of his important explorations in South Africa. They have also in the press Signor D'Albertis' Narrative of his Explorations in New Guinea; it will contain many illustrations in ethnography and natural history.

THE last *Zeitschrift* of the Berlin Geographical Society contains detailed narratives by Dr. Hildebrandt of his important journey from Mombassa to Kitur, and by Dr. Hirschfeld of a journey he made in South-West Asia Minor. The *Verhandlungen* contains a valuable description of the Galapagos Islands, by Dr. Theodor Wolf, and a series of measurements of elevations in Ecuador, by the same, both from the Spanish of W. Reiss.

FROM the American Geographical Society we have received the annual address of the president, Dr. C. P. Daly, being an elaborate and valuable paper on the Early History of Cartography, or, "Maps and Map-Making before the time of Mercator." The paper is profusely illustrated with specimens of old maps, and must have involved a great amount of research. The last *Bulletin* of the Society (No. 5 of 1878) contains a long account of a journey along the west coast of South America, from

Panama to Valparaiso, by Mr. James Douglas, and an account of a visit to the "Wonderful Rivers of Cambodia," by Mr. Frank Vincent.

DR. CREVAUX, the explorer of French Guiana, is not yet, it seems, coming home, but will attempt to reach the Andes by the Iça or Putumayo, exploring that water-system as he has already done the Marori, Ozapok, Yary, and Para.

OUR ASTRONOMICAL COLUMN

BIELA'S COMET.—Even if the earth should encounter an unusual number of meteors on arriving at the descending-node of Biela's comet next month, as some have anticipated, the display is likely to be masked to a considerable extent by overpowering moonlight. The earth will reach the node (so far as we can judge of its actual position) on November 27, and the moon will be full on the following day. Remembering that the meteors of 1872 were not generally remarkable for brightness, though there were some notable exceptions, should there be a return of the shower, a large proportion may escape notice. No doubt, however, a strict watch will be maintained during the last week in November. We are not able to judge how near we may be to the meteoric mass which the earth met on November 27, 1872; it would arrive at perihelion at the end of December in that year, but we do not know the exact period in which it was revolving.

It is worthy of note that the effect of the differences of mean anomalies and mean motions when the two nuclei of the comet were last observed in 1852, would in 1879 occasion a difference in the times of perihelion passage to the extent of nearly 3½ days, and the mutual distance of the nuclei would be increased to 0·075 of the earth's mean distance from the sun, or nearly 7,000,000 miles.

Between the year 1772, when the comet was first observed, and 1852, when the last observations were obtained, the node had retrograded upwards of 11°, the perturbation being chiefly caused by the planet Jupiter in 1794, 1831, and 1842.

When we consider the conditions under which Biela's comet appeared in 1805, we are struck with the favourable opportunity which the repetition of such a case may afford for a precise determination of the solar parallax. On the evening of December 8 in that year the comet at transit at Greenwich was distant from the earth less than 0·038, and its horizontal parallax was upwards of *four minutes;* at this time, with a declination of near 24° south, it was rapidly descending below the horizon in Europe, still it was well observable, and of course would have been in a very good position for observation at the Cape of Good Hope. Its appearance also was favourable for accurate observations, which is more than can be said of all comets that have approached near to the earth. Olbers mentions that on this evening when he was observing with Bessel, the nucleus was very small and defined like a planet, and Gauss at the same time compares it to a star of the third or fourth magnitude. There has been no such opportunity since the Cape Observatory was established.

THE GALLERIES OF THE CUTTING ANTS OF TEXAS

MR. McCOOK, the devoted student of insects, has in preparation a memoir, which will be looked for with the intensest interest, resulting from his prolonged investigations into the life-history of the cutting or "parasol" ants of Texas (*Atta fervens*), bidding fair to rival his work upon the agricultural ants.

First, let us take with Mr. McCook a brief view of a denuded surface on a high grassy prairie, covered with a number of small moundlets of fresh earth-pellets, yet without a sign of life, and looking entirely abandoned; over its surface were seen little heaps of dry twigs and pieces of leaves. But towards evening, hosts of ants hurried out, and formed two long double columns to the top of an overhanging live-oak. The ants in the descending columns all carried above their heads portions of green leaves, whence they derive their popular name of "parasol" ants. The closing of the gates in the morning came to pass thus:—Bits of dry twigs and leaves of various lengths are carried into the gallery, filling it up from half an inch to an inch and a half below the surface; often the galleries slant inwards, even to 45°; or divide soon. The larger "castes" carry in the refuse; as the hole closes the smaller castes appear. The "minims," in small squads, fill in all interstices with minute grains of sand, and finally the last steals in behind some bit of leaf, and the establishment is closed. The reverse takes place, when outside work is resumed in the evening. When the larger forms get out they at first carry away and drop their burdens, and little seems to be accomplished for a long time. But in a marvellous way there occurs a final rush, by which the gate is opened. The bigger pieces of twigs are evidently regarded as special treasures, and were seen used on several successive days. The use of the smallest castes is thus found; some remain at only one-sixteenth of an inch long, while the fertile female attains nearly an inch, and the male is three-fourths of an inch long. The interior of the formicary is composed of caverns or pockets communicating with the surface and with each other by tubular galleries. The chambers contained masses of very delicate leaf-paper wrought into rude combs. Some masses were hemispheres in shape, others were arranged in columns two and a half inches high, in contact, along the floor of the chambers, whose dimensions might be nearly three feet by one foot, and eight inches high. Some hung from tree-roots which passed through the chamber. All this material was composed of the fibre of leaves reduced to this form within the nest. In each portion of ant-comb the cells were nearly hexagonal, but very varied in size, some being half an inch in diameter, but most of them as minute as one-eighth of an inch. Large circular openings ran into the heart of the mass. Ants of the small castes were very numerous in these cells. The material of the comb was very fragile and perishable. It is supposed by Mr. McCook that the ants feed upon the juices of the leaves, but this waits further confirmation. Some of these chambers are even of very large dimensions; one of the size of a flour-barrel was seen, being the main cavity of a formicary, in which were found very many winged males and females and larvæ. This was situated 669 feet from a tree that stood in the front yard of a house, which these ants had stripped. Mr. McCook took a plan of the underground way traversed by the ants to reach this point; the course varied very little from a straight line; two branches had been made to a peach orchard 120 feet distant. Only the small forms appear to take part in the digging, while the larger assist in opening the gates, make the excursions, and do the leaf cutting. The least forms, or minims, assist in opening and closing doors, and taking charge of larvæ. The minims are quite ferocious in attack, and gallantly support the large-headed soldiers. The process of leaf-cutting has been so successfully observed by Mr. McCook, that it is quite deserving of further notice, which we hope soon to give.

G. T. BETTANY

ROUTES TO CHINA *viâ* ASAM

THE possibility of connecting India with China by a tolerably direct and easy trade route overland is a question of increasing interest to us all, in India and England. Not only would such a route benefit the large valley of Asam, by causing an influx of labour more or

less useful for the growth and manufacture of tea, and convert it from a *cul-de-sac* into a great highway. But the spectacle would be removed of two large and populous empires touching each other, and in harmony, yet having no direct intercourse.

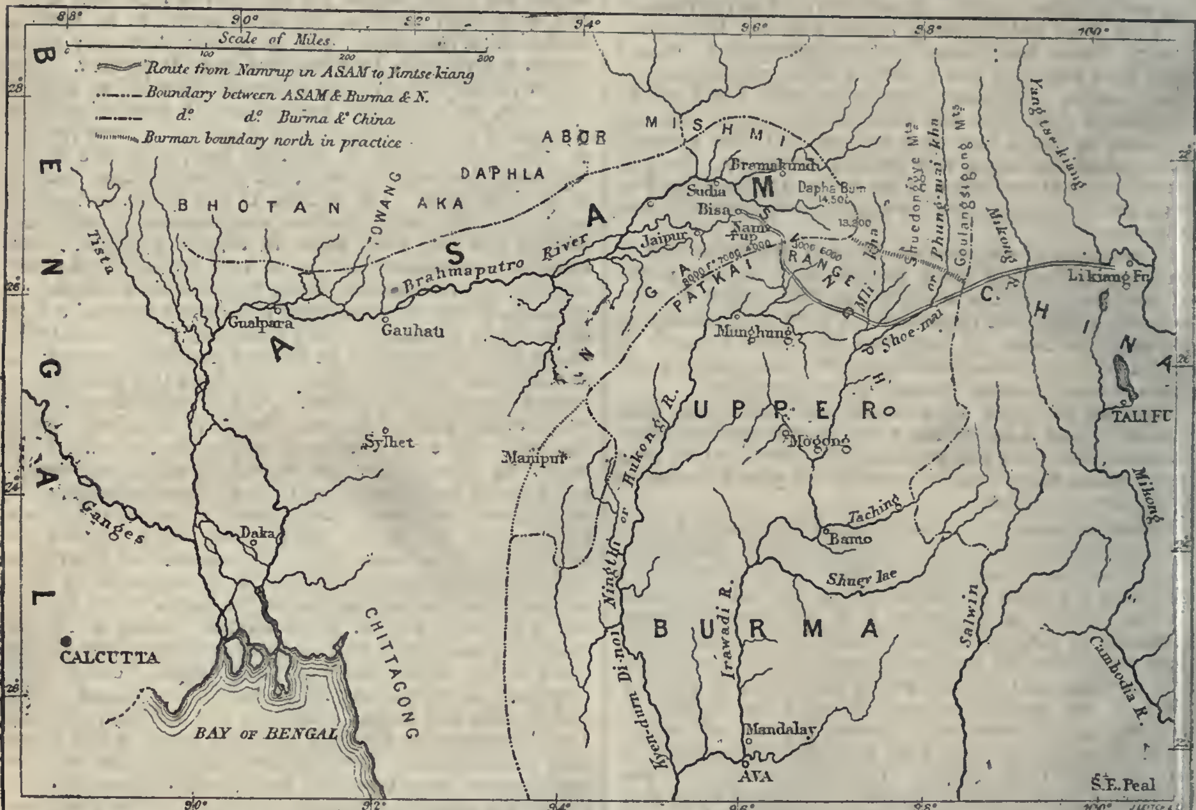
In past times this subject received careful attention from those who were in a position to judge of the relative values of the various routes, and whether *viâ* Kamaun, Nipal, Sikim, Bhutan, or the Mishmi Hills the elevations were found to range from 10,000 to 18,000 feet, often at several points on each line, and there has been an almost unanimous agreement that the route from Asam *viâ* Patkai and Hukong Valley presents the least difficulty.

Pemberton, in his report on the north-eastern frontier in 1835, after a survey of Munipúr, Passage through the Naga Hills and knowledge of the Bhutan frontier, unhesitatingly reports it as the best route "presenting no serious obstacles."

The late General Francis Jenkins (Governor-General's agent in Asam from 1834 to 1868) was well acquainted with the various routes, and says :—"By this pass is—to the best of my information—the only practicable line throughout the encircling mountain ranges from Asam and India into Burmese territory, and thence to China."

Lieut. Charlton also, who had experience on this question, says (*Journal A.S.B.*, 1835):—"What a pity there is no means of communication between Sadia and Yunan, a good land road, and there are no natural obstacles of any consequence to prevent it, would afford an outlet for British merchandise into the very heart of China."

In 1868 and also in 1869 Mr. H. L. Jenkins crossed Patkai near the site of the old route, and demonstrated that the only obstacles of any note were of a political, and not a physical nature (*Proceedings, A.S. Bengal*, July, 1870, p. 230). In January last, 1879, the Chief Commissioner of Asam kindly permitted me to cross the Patkai and ascer-



MAP SHEWING THE PROPOSED ROUTE ACROSS PATKAI TO CHINA.

tain relative and actual elevations, and briefly I may say that the extreme altitude of the track where I crossed the range is 3,445 feet above the sea, and 2,734 feet above the level of the Asam valley, the descent on the Burma side being about 1,000 or 1,200 feet only, the passage from the river levels of one side to the other being always done in one day, or one and a half if herds of cattle are taken; but it is noteworthy that the range is much lower at a short distance to the east, where it is easily seen that passes exist at 2,000 feet or less, where the old track is reputed to have been, by which the Ahoms and the Burmese army entered. The whole range is covered by a dense tree jungle, and any one acquainted with the sturdy hillmen who use this track will understand that the present route is selected simply because it presents an easy passage. The trouble of climbing a few hundred feet more or less is of little consequence to these hardy mountaineers. It is also near some villages where provisions are procurable, the country east being absolutely uninhabited.

After crossing Patkai I descended to the Nongyang Lake, a sheet of water about 1,800 by 1,000 yards, lying in an open flat grassy valley, about 10 miles long by 2 or 3 broad. As I had taken a *Rob Roy* canoe with me, I was able to get out on the lake and had a good view of the range; the lake and valley level stands from 1,500 to 2,000 feet above that of Asam. On returning, my party crossed from the Nongyang Lake on the Burmese side to the river Nunki on the Asam side, in about seven hours of actual travel.

Hitherto the great obstacle to any route this way was thought to be difficulty of crossing Patkai; it was considered an impassable barrier, even by those in favour of a joint route from Asam and Upper Burma. But it is now clear that this barrier does not exist, and that an

easy and low route is possible. Thus the first step in a good and easy trade route out of India is secured, and secured here alone.

From Nongyang the usual route for traders is *viâ* Namyung, Songphú village in a level plain of same name, thence *viâ* the Turong villages and rolling slopes of the upper part of the Dinoi valley and the low Kako hills dividing it from the Irawadi. On crossing this latter two routes are available, one up the Shoemai Kha and Sittang flat country, the other more east, turning the southern extremity of the Goulang si gong range, that coming down from the north divides Burma from China. Such a route would also pass round the heads of the Taeping, Shueylí, and Salwín valleys, and leave but one large stream, the Mikong, to cross ere reaching the Yangtse Kiang, at a point near Li kiang fu, navigable at all seasons—the main artery of China. The total distance of such a route from the plains of Asam at the Namphuk to the Yangtse I estimate at 300 miles to 350, including windings, and to clear out a serviceable bridle path or fair weather road on this I estimate would cost but 10,000*l*. The present path for long distances is a mere jungle track often obstructed by fallen trees; small deep gullies necessitate long *détours*. Were some of the jungle removed and fallen trees, a few strong logs felled over the little streams would make a good commencement.

I need not say much regarding the advantages of such a route, if available. For political reasons it was once thought desirable to discourage direct intercourse between India and China; but that day has departed. England is now one of the three great Asiatic powers, and the time has arrived when we must not only examine our passes west and east, but cultivate as far as possible a profitable and peaceful intercourse with China. The state of Upper Burma (once a Chinese province) simply renders this question urgent. At a time also when Australia and America are invaded by such hordes of cheap labourers, labour paying heavily for its own transport to distant and overstocked markets, we see Asam—close to the labour source—suffering from a want of it, and planters paying Rs. 80 and Rs. 100 per head ere they can employ labour of a very inferior stamp.

S. E. PEAL

KARL FRIEDRICH MOHR

BY the death of Dr. Mohr, of Bonn, which is just announced, the science of chemistry has lost a worker whose labours have extended over nearly half a century, and have led to great and valuable results.

Dr. Karl Friedrich Mohr was born at Coblenz in November, 1806. His earliest work was devoted to the continuation of the Pharmacopœia, established by Geiger. The work by which he will be best remembered is the "Lehrbuch der chemisch-analytische Titrirmethode," which appeared in 1855 and 1856, the second, and considerably enlarged edition, appearing in 1862. His published papers, which are very numerous, arrange themselves in two classes mainly, those devoted to meteorology and those having a bearing on volumetric analysis. Ground-ice, the earliest information about ozone, St. Elmo's fire are among the subjects of his earliest, and among his later the lower ends of lightning conductors, hail and rain, and confirmation of his theory of the formation of hail. The other more numerous class of papers on analysis extend over nearly fifty years. His examination of the method of separating copper and silver appeared in Liebig's *Annalen der Chemie* in 1832, to be followed by others on the condensation of chlorine, on Marsh's method, preparation of barium hydrate, the reduction of silver chloride, the action of the air on arsenides, and thirty years later on the value of indirect analysis, on nitrate determinations, the estimation of the different oxides of manganese, analysis without the use of weights, examination of a method of determining the specific gravity of liquids with a watch, phosphoric acid determinations, &c.

About ten years ago he published his "Allgemeine Theorie der Bewegung und Kraft," and shortly afterwards "Mechanische Theorie der chemischen Affinität."

About four years ago he sent to Liebig's *Annalen der Chemie* a curious paper on the nature and mode of origin of meteorites. He finds that all the silicates present in meteorites contain a little water, and when heated strongly or fused have a decreased specific gravity; that some meteorites contain organic compounds like certain terrestrial carbon compounds, but that meteoric iron contains no combined carbon.

THE INTERNATIONAL ASTRONOMICAL SOCIETY

THE eighth Annual Meeting of this Association was held at Berlin on September 5 to 8. The sixth and seventh meetings of the Society were held at Leyden (1875) and at Stockholm (1877). At the latter place Berlin was selected for the next general meeting, to be held in the present year. This city being more centrally situated for the greater part of the members than Leyden or Stockholm, it was expected that a rather large proportion of the Fellows of the Society would meet there; and so it has proved. There were present the following sixty-one astronomers, mechanicians, and opticians:—Abbe (Jena), Auwers (Berlin), Baeker (Nauen), de Ball (Gotha), H. G. van de Sande Bakhuyzen (Leyden), Bamberg (Berlin), Bansa (Frankfort), Becker (Berlin), Behrmann (Elsfleth), Bergmann (Berlin), Boguslawski (Berlin), Bruhns (Leipzig), Bruns (Berlin), Denker (Hamburg), Drechsler (Dresden), Elkin (New Orleans), Engelmann (Leipzig), Förster (Berlin), Franz (Königsberg), Friesach (Graz), Fuess (Berlin), Galle (Breslau), Gyldèn (Stockholm), Hasselberg (Pulkowa), Huggins (London), Kempf (Potsdam), v. Knorre (Berlin), Kreutz (Bonn), Krüger (Gotha), Küstner (Strassburg), Lehmann (Berlin), Lehman-Filhès (Berlin), Lohse (Potsdam), Maywald (Berlin), Merz (Munich), Möller (Lund), Müller (Potsdam), Neumeyer (Hamburg), Oppenheim (Berlin), Oudemans (Utrecht), Palisa (Pola), Pechüle (Copenhagen), v. Plaenckner (Gotha), Pihl (Christiania), Reichel (Berlin), O. Repsold (Hamburg), Romberg (Pulkowa), Rosèn (Stockholm), Rümker (Hamburg), Safarik (Prag), Schönfeld (Bonn), Spörer (Potsdam), Tiede (Berlin), Tiele (Copenhagen), Tietjen (Berlin), Valentiner (Mannheim), Vogel (Potsdam), Wanschaffe (Berlin), Winkler (Leipzig), Winnecke (Strassburg), Wittstein (Leipzig). Hence, besides forty-six Germans, there were present three Fellows from Austria, three from Sweden, two from Holland, two from Denmark, two from Russia, and one each from America, England, and Norway.

The Council, composed of Prof. Krüger, President, Prof. Förster, Prof. Gyldèn, Prof. van de Sande Bakhuyzen, Vice-presidents; Prof. Bruhns, Librarian, Director Auerbach, Treasurer; Secretaries, Professors Schönfeld and Winnecke, met on September 1, to consider the matters to be submitted to the meeting.

The day before the opening of the general meeting there was unveiled at the Berlin Observatory, in the presence of Encke's son and daughter, surrounded by many distinguished guests, the bust of the distinguished astronomer, who founded the new observatory at Berlin, and rendered it famous by incessant labour. The bust was made by the celebrated artist, Afinger. Prof. Förster, to whose exertions this acknowledgment of his predecessor is due, recalled to the assembled guests in spirited words the great astronomer's principal merits.

On September 5 the general meeting was opened at ten o'clock in the morning by Prof. Krüger, in the lecture hall of the Royal Academy of Sciences. The Minister for Public Instruction, Herr von Puttkammer, welcomed

the assembly in the name of the Prussian Government, and said that he hoped the new arrangements at the Royal Observatory in Berlin, and the newly-finished Astro-Physical Observatory at Potsdam would be objects worthy of the attention of foreign astronomers.

The President, after having thanked the Minister for Public Instruction, gave a summary of the number of Fellows of the Society. At Stockholm the Society had 258 Fellows; nine of these died, one left the Society, and thirty-five new Members were provisionally admitted by the Council, the number of Fellows being therefore at present 283. It is well understood that by the bye-laws of the Society there are no Associates or Honorary Members. Prof. Krüger then read an historical account, composed by the Council, of those transactions which induced Herr Struve, Director of the Imperial Observatory at Pulkowa, to resign, last year, the office of president. Then the Reports on the business during 1877-79 were read.

The treasurer (Herr Auerbach) not being able to be present at the meeting, Prof. Bruhns read his report on the expenses and the income of the Society. Besides the stock of the various publications, the *Vierteljahrsschrift* and some astronomical instruments, the Society has invested about 40,000 marks.

The librarian (Prof. Bruhns) gave a summary of books received, and stated that a catalogue of all the books had been prepared, and that it was passing through the press.

The secretary (Prof. Winnecke) reported on the publications. There have been printed and distributed to the Fellows since the Stockholm meeting, nine Hefte of the *Vierteljahrsschrift*, viz., vol. xii. Heft 4, vol. xiii. and vol. xiv. Hefte 1-3; he mentioned that it had been tried to add to the biographical notices on deceased astronomers their portraits in photography. Of the quarto publications there had just appeared:—

No. xiv. — "Fundamental-Catalog für die Zonenbeobachtungen am nördlichen Himmel. Herausgegeben im Auftrage der Zonencommission der Astron. Gesellschaft von A. Auwers."

No. xv.—E. Hartwig, "Untersuchungen über die Durchmesser der Planeten Venus und Mars nach Heliometermessungen auf der provisorischen Universitätsternwarte zu Strassburg, mit Hinzuziehung der anderweitigen vorhandenen Mikrometerbeobachtungen."

The "Ephemeriden der Fundamentalsterne für die Zonenbeobachtungen" for the year 1880, published by the *Redaction* of the *Berliner Jahrbuch*, in co-operation with the Society, has just been issued. Further, two small volumes have been printed for private circulation, the one containing the Minutes of the Council Meetings, the other giving extracts of the *Transactions* of the Council by letter.

The reading of the reports was interrupted by Prof. Förster inviting the members to visit, in the afternoon, the Royal Observatory. He gave a lucid exposition of the arrangements of the newly reconstructed observing rooms. He had had in view to get the temperature in the meridian room as far as possible identical with the outer one. There was constructed a new cupola for an equatorial of 8 feet, and a revolving roof for a new transit, to be used in different azimuths.

For the next day Prof. Förster proposed to visit Potsdam. There the just finished Astro-Physical Observatory should be inspected, and in the evening there would be a *soirée* given by the Government at Glienicke. Prof. Bruhns then read the report on the progress of cometary astronomy; in connection with it Prof. Gyldèn made some remarks on the computations by Dr. Backlund, of Pulkowa, of the absolute perturbations of Encke's comet by his new method.

There were proposed as places for the next meeting in 1881, Strassburg (Winnecke), Graz (Friesach), Brussels (Gyldèn); the election took place on the day following. Prof. Winnecke then gave, in support of his invitation to Strassburg, a detailed account of the new observatory now nearly finished there, and illustrated it with many drawings, representing the buildings, and explaining the manner of constructing the domes and laying the foundation for the pillars. There had to be provided observing rooms for the equatorial (object-glass 18 Paris inches), an orbit-sweeper (6 inches), the Repsold meridian-circle (6 inches), the altazimuth (5 inches), the Cauxoix-transit (5 inches), and different smaller instruments. There were a great many peculiarities differing from existing observatories, and Prof. Winnecke was very anxious to know if these innovations would turn out to be improvements.

Dr. Hasselberg (Pulkowa) spoke of the light emitted by gases induced by electricity and low temperature.

Dr. Drechsler (Dresden) reported on the collections of the Mathematical Saloon at Dresden, and distributed copies of a catalogue of them.

Prof. Saffarik (Prague) spoke on his observations on the colour of stars, principally on those of α Ursæ maj., the colour of which is said to be considerably and periodically variable. His own results do not confirm at all the supposed variability. This matter was then discussed between Herren Oudemans, Saffarik, and Winnecke.

Prof. Förster laid before the meeting (1) a volume, just published, in German, containing the observations of Dr. v. Konkoly at O'Gyalla; (2) different drawings of nebula from Herr Tempel at Arcetri; (3) an account by Dr. v. Konkoly of the new observatory, established in Hungary, at Kalocsa, by the Archbishop of Haynald. The director of this new observatory is Dr. Braun, well known by his attempts to register automatically the transits of stars.

September 6.—Prof. Auwers (Berlin) read the report on the principal undertaking of the Society, to fix by exact observation the places of all the stars down to the 9th magnitude, contained in Argelander's "Durchmusterung des nördlichen Himmels," the number of which is about 200,000. The observatories either busily engaged or having finished the part allotted to them in this work are: Nicolajew (Russia), Albany (U.S.A.), Leipzig (Germany), Lund (Sweden), Berlin (Germany), Leyden (Holland), Bonn (Germany), Helsingfors (Finland), Dorpat (Russia), Christiania (Norway), Kasan (Russia). The printing of some parts of the Catalogue will probably commence very soon, and it is to be hoped the grand work will be finished in a few years.

As the place for the next meeting (1881) the votes were nearly unanimous for Strassburg.

Prof. Gyldèn (Stockholm) expounded a new theory of the variability of stars, trying to reduce the problem to mechanical principles and expounding his views of overcoming the mathematical difficulties.

Dr. Schröder (Hamburg) gave an account of his proceedings in practical optics, aided by theoretical researches. As the hour of leaving for Potsdam was near, he delayed the exhibition of some specimens of his skill to Monday.

September 8.—According to the new elections made at the beginning of this meeting, the Council of the Society is composed, for the period 1879-81, as follows:—President, Prof. Krüger (Gotha); Vice-Presidents: Prof. Auwers (Berlin), Prof. Gyldèn (Stockholm), Prof. van de Sande Bakhuyzen (Leyden); Secretaries: Professors Schönfeld (Bonn), Winnecke (Strassburg); Librarian, Prof. Bruhns (Leipzig); Treasurer, Director Auerbach (Leipzig).

Prof. Tietjen (Berlin) read the report on the small planets, followed by a discussion between Herren Bruhns, Förster, and Oudemans.

Director Palisa (Pola) moved:—"To invite the Council of the Society to consider the means of arranging a better and more economical organisation of the present system of telegraphic announcement of new astronomical dis-

coveries." This motion, after some discussion, was carried unanimously.

Dr. Schröder (Hamburg) then finished the communication begun at the previous meeting. Herren Abbe (Jena), Saffarik (Prague), Bruhns (Leipzig), Winnecke (Strassburg), took part in the discussion on it. Prof. Oudemans (Utrecht) reported on the Gaussian object-glass of the Utrecht Observatory. Dr. Huggins (London) gave an account of his results in photographing star-spectra, and showed some of them to the meeting. Prof. Bruhns (Leipzig) exhibited drawings of nebula and neighbouring stars made by students of the University with small telescopes. Prof. Abbe (Jena) gave an elaborate account of his important theoretical and experimental researches in optics, followed by a discussion between him and Herren Förster and Winnecke. Prof. van de Sande Bakhuyzen (Leyden) explained his researches upon the dependance of the personal error in transit observations from the magnitude of the stars. Prof. Schönfeld (Bonn) reported on the progress of his "Durchmusterung" of the southern heavens. There is finished in observation at present about two-thirds of the whole work.

After a vote of thanks to the Prussian Government, the Royal Academy of Sciences, and the Berlin astronomers, the meeting of the International Astronomical Society was closed late in the afternoon. A. WINNECKE

INFLUENCE OF ELECTRICITY ON VEGETATION

SEVERAL months ago, it will be remembered, M. Grandeau described to the Paris Academy experiments made by himself and M. Leclerc at Nancy and Mettray, whence it appeared that flowering and fructification are retarded and impoverished if plants are excluded from the influence of atmospheric electricity—as by being inclosed in a metallic cage, or being near trees or other objects which may carry off electricity of the air.

Recently M. Naudin has repeated the experiments referred to, but with other plants and in a different climate, and, without wishing to contradict the conclusions arrived at for tobacco and maize (the plants that had been experimented with), he is led to regard the declarations made as too general, inasmuch as his results are almost exactly opposite to those obtained by MM. Grandeau and Leclerc.

It was at Antibes, in the large botanical garden formed by the late Thuret (now Government property), that M. Naudin made his experiments. He had an iron quadrangular cage made, covering a surface of fifty-one square decimetres, and about one metre in height; the frame carried points above (like small lightning conductors), and was covered with iron netting, the lozenge-meshes of this being 0·09m. long by 0·054 m. broad (it intercepted more light than M. Grandeau's, but this is thought insignificant). The cage was placed in a kitchen garden, and the plants it was made to inclose were kidney beans, lettuce, tomato, and herbaceous cotton (the last alone being sown as seed). In the same garden, at 7 metres distance, plants as like the others as possible were planted, and cotton seeds of the same kind sown, but without a cage-cover. The soil was perfectly homogeneous throughout, and all parts of the plot were equally exposed to sunlight, dew, and rain. The experiment began on May 25.

For a fortnight there appeared no sensible difference between the two portions; but about the middle of June it was remarked that the plants of the cage were stronger than those in the open air, and this difference became more pronounced as time went on. The plants, indeed, progressed side by side in this sense, that the flowerings were absolutely contemporaneous in the plants of the same species; and it was the same with formation and maturation of fruits. But it was quite otherwise with the quantity of vegetable matter produced in a given time and on the same extent of soil, and this difference was entirely in favour of the caged plants.

We may take the figures tabulated by M. Naudin for the tomato (examined August 14), as a good example of this:—

	Tomato in open air.	Tomato under the cage.
Length of the principal stem ...	0·80 m.	... 1·0 m.
Total weight of the plant cut at the level of the ground, fruits included	2·072 kg.	... 3·754 kg.
Number of ripe fruits and green fruits of all sizes ...	37	... 83
Weight of the whole of the fruit detached from the plant	1·80 kg.	... 2·162 kg.

The other plants gave a similar testimony in favour of the withdrawal of atmospheric electricity. Thus, the total weights of the bean plants were respectively 142 gr. and 167 gr.; and of the lettuce 337 gr. and 427 gr. The cotton plants were weakly (as there had been no watering), but their evidence was in the same line as that of the others.

The injurious influence, which, according to M. Grandeau's theory, trees exert on plants in their neighbourhood, by withdrawing atmospheric electricity, is also considered by M. Naudin to be only a special case. Besides, it is easy to ascribe to this withdrawal what is merely the result of the shade cast by trees, and especially of the exhaustion and desiccation of the ground by their roots, which often extend to a great distance. On the other hand there are many plants which seek the neighbourhood of trees, and which even thrive only under their shadow, and these, probably, must be adapted to a diminution of atmospheric electricity. At the Villa Thuret, M. Naudin remarks, there are several lawns quite inclosed by trees (pines, firs, cypresses, &c.), many of which are adult and of pretty good size. These lawns contain, besides their grass, thousands of anemones (*A. pavonina*, *A. cyanea*, *A. stellati*), some of pure race, others hybrid, whose flowers present all shades of red, rose, purple, white, and blue. The appearance is striking when the flowers come out in March or April. The flowering is not entirely contemporaneous throughout the lawn; it begins near the trees, and gradually extends to the middle of the lawn; the difference of time between these two extremes being twelve to fifteen days. Moreover, the anemones nearest to the trees, in addition to their relative precocity, are generally stronger and taller, and have broader, perhaps more brightly coloured corollas, than those in the middle of the lawn.

From the observations described, M. Naudin is disposed to think the question as to the influence of atmospheric electricity on plants is complex, and far from being decided as yet. This influence, in all probability, is modified first by the very essence of the species, which must behave, in regard to atmospheric electricity, as to other agents of vegetation, that is to say, in very diverse manners; then it is modified by climate, season, temperature, degree of light, dry or wet weather, perhaps also by the geological structure or mineralogical composition of the ground, the layers of which, superficial or deep, may not be equally conductive of electricity. It is possible, lastly, that all tree species may not alike withdraw the electric *effluves* of the atmosphere, and this is a point necessary to be determined. Until these numerous and so obscure conditions of the problem before us are sufficiently known, we should regard as premature any conclusion which is applied to the whole, or even only to the generality of the vegetable kingdom.

THE DIFFUSION OF LIQUIDS

IT is fortunate that various branches of the work with which Graham's name will always be connected are now attracting the attention of physicists. At the

beginning of this year Prof. Osborne Reynolds gave, in a remarkable paper,[1] the results of experimental researches "On Thermal Transpiration of Gases through Porous Plates," and showed the existence of a class of very marked phenomena which had escaped the notice of other observers. More recently Dr. John H. Long has studied the diffusion of liquids,[2] starting from the work of Graham, which must be regarded as the first and only general investigation of this subject we possess. Dr. Long's results will be briefly given in his own words, but it may be well to draw attention, as he does, to a few facts connected with the history of the subject. In two papers read before the Royal Society in 1850, Graham established that—

1. The velocity of diffusion is different for each substance in solution.

2. The amounts of salt diffused in a given time from solutions of the same substance, but different concentrations, are very nearly proportional to the concentration.

3. The amount of salt diffused from a given solution increases with the temperature.

Fick subsequently showed that liquid diffusion may be compared to the conduction of heat, that is, the spread of salt particles through water is in many respects analogous to the spread of heat in a conducting body, and that formulæ, similar to those established by Fourier for the latter case, may be applied in the former.

Certain experimentalists then employed optical methods of observation in determining the rate of diffusion of salts in solution, but Stefan showed that the optical methods "are based on a false assumption, and that they can therefore give only false results." It will be sufficient to state, however, that after a careful review of the work of the several investigators, Dr. Long divides the researches into two classes:—

1. Those which are concerned with the physical side of the question, that is, with the determination of "the constant of diffusion" for a single substance. To this class belong the researches of Fick, Simmler, and Wild, Voit, Hoppe-Seyler, Johannisjanz, Weber, and Stefan.

2. Those which treat the subject from a chemical point of view, by comparing the rates of diffusion of many different substances. To this class belong the investigations of Graham, Beilstein, and Marignac. Dr. Long points out that "in regard to the first class it may be said that a very satisfactory end has been attained. The proof of Fick's law by Weber and Stefan, and the determination of the influence of temperature and concentration of solution by the former, leave little to be desired in connection with this part of the subject. The same cannot be said, however, of the other, the chemical side." The experiments of Beilstein are not sufficiently numerous to establish much with certainty, and those of Graham and Marignac, while agreeing well among themselves, do not establish the dependence of diffusion on the molecular weight or other physical property of the substance employed.

Facts such as these have led Dr. Long to undertake a lengthy series of experiments, in which he employed a method that renders it possible to determine the rate of diffusion from hour to hour, and to insure that the diffusion takes place into a medium whose concentration is always zero. His apparatus may be roughly described as consisting of a U-tube placed in a beaker, which contains the solution to be investigated. The ends of the tube are bent over the beaker, one end being connected with a funnel into which water slowly drops, displacing the solution in the U-tube, which flows out from the other end at about the rate of 40 cc. in an hour. The base of the U-tube is open, and is connected with a short vertical tube whose internal diameter is 15 mm. This larger tube is open only at the bottom, and is arranged concentrically with the beaker.

[1] *Proc.* Roy. Soc., 1879, p. 304.

[2] A dissertation presented to the Faculty of Science of the University of Tübingen, 1879.

Diffusion thus takes place between the solution *below* the line of junction of the short tube with the U-tube and the water contained in the latter, the diffused particles being carried away and discharged; in other words, there is diffusion between a level of constant concentration and a level "of concentration zero." Space will only permit us to notice the general conclusions at which Dr. Long has arrived. He observes that no simple relation is recognisable between diffusion and other physical phenomena if we merely state the results in *grammes* of substance diffused. If, on the other hand, the results are stated as the numbers of *molecules* diffused, several interesting relations appear. For instance, it can be shown that the chlorides, bromides, and iodides of the alkaline metals form a series in which NH_4 stands between K and Na; and in this series the chloride, bromide, iodide, and cyanide of potassium have nearly the same rate. The chlorides of the dyad metals Ba, Sr, Cr, and Mg are also seen to form a series as to their rates of diffusion. It can further be shown, by comparing Kohlrausch's results on the electrical conducting power of liquids with the diffusion rates, that those salts which in solution offer the least resistance to the passage of the galvanic current are the ones which diffuse most rapidly. In most cases it appears that the salts having the greatest molecular volume diffuse the best, and those salts which absorb the greatest amount of heat on passing into solution are also the ones which diffuse most rapidly.

Dr. Long shows that Graham's view that no relation exists between the molecular weight and the rate of diffusion requires modification, for the alkaline chlorides, bromides, and iodides stand in the same order as regards molecular volume, rate of diffusion, conducting power, and latent heat of solution.

In conclusion Dr. Long indicates the direction in which he proposes to continue the research, which, we may add, bears evidence of being the work of an able physicist, from whom many valuable researches may be expected. W. CHANDLER ROBERTS

THE PARKES MUSEUM OF HYGIENE

THERE is one all important matter with which neither the great Institution in Bloomsbury nor that at South Kensington has virtually any concern; this important matter is Hygiene, the knowledge and application of the laws of life, which in so far as they are perfect banish disease from the human race. The Parkes Museum of Hygiene has been formed to promote this department of the numerous applications of science.

In the spring of 1876 the movement for the formation of the Parkes Museum commenced. It was the outcome of a very general desire to perpetuate in some useful way the memory of the late Dr. Parkes, whose life had been so unselfishly spent in promoting the welfare and happiness of his fellows by extending the knowledge of the laws of health, and whose untiring energy and keen intellect did such good service in clearing away the ignorance and superstition which accepted disease as the inevitable accompaniment of human life in this world. The movement rapidly developed into shape, and finally the Parkes Museum of Hygiene was opened to the public in June last, with a fairly representative collection of mechanical appliances, models, plans, and books, designed to promote health, of which a descriptive and illustrated catalogue was published. Since then so many valuable additions have been made to the museum that an enlarged and improved catalogue has been issued. The affairs of the museum are administered by an executive committee of which Sir William Jenner is chairman, and at present the cost of maintaining the museum has to be met wholly by voluntary contributions. The collection of appliances, models, &c., is temporarily located in the largest room of the south wing of University College, which, together

with a second room for the Library, has been generously placed at the disposal of the executive committee, by the council of the College, until such time as a separate building can be provided for the museum. The articles exhibited are arranged in six classes, and a brief description of these will serve to indicate sufficiently that the museum is likely to be of great service to those engaged in studying the sanitary construction of houses and other branches of hygiene. It should be stated that the classification is only a temporary one.

In Class I. (Engineering) will be found plans, sections, and models of systems of drainage for cities, towns, and villages, including the whole of the contract drawings used in connection with the construction of the present system of drainage in the metropolis. Maps, &c., illustrating the physical geography of this and other countries, plans of existing and proposed means of water supply for towns, sections of geological formations, and views of the position and surroundings of places noted as health resorts, apparatus in connection with water-supply, and the sinking of wells, are also included in this class.

Class II. (Architecture) consists of general designs for dwellings, hospitals, and other buildings, together with examples of the details of construction. This is by far the largest and most complete section of the museum; already it includes hundreds of models, or specimens of mechanical appliances, and modes of building construction—illustrating in detail the several parts of a well-built house, from the foundation to the roof—bricks, concrete, and other material for walls; artificial stone as a fireproof substitute for timber, &c., so commonly used for heads over door and window openings; also water-closets of every description; baths; stoneware, lead, and iron pipes; syphon and other traps; yard gullies, and contrivances for disconnecting the main sewers from the house pipes, may be seen and compared. Windows and doors so arranged as to give ventilation to the apartment in which they are fixed, stoves of various kinds, ventilating gas lamps, cowls for chimneys, and soil pipes, and other mechanical appliances designed to promote health in connection with architecture, make up this department.

In Class III. (Furnishing) are arranged specimens of school and household furniture presenting features of hygienic interest, including English and foreign oil lamps, specimens of wall papers, arsenical and non-arsenical; and here it may be interesting to state that the library of the museum has been decorated throughout with the new paint, in which zinc white is used as a substitute for white lead.

Class IV. (Clothing) is intended to include fabrics of various kinds used for clothing, with explanation of their properties and uses; but at present this class is only represented by some specimens of army clothing, and a few articles of dress coloured with arsenical pigments.

Class V. (Food) has been largely contributed by the authorities at South Kensington and Kew. It includes a number of large diagrams illustrating the component parts of food and the adulteration of articles of food in common use; samples of gluten bread and other foods for invalids; preserved fruits, seeds, &c.; different kinds of filters, and samples of water.

Class VI. (Preservation and Relief) is composed of all that relates to the hospital, the prevention of accidents or diseases peculiar to certain trades or occupations; disease charts, means for safety and rescue in case of fire, or accidents at sea; stoves for disinfecting purposes, Turkish bath apparatus, &c.

A library is being formed of books relating to hygiene. Exclusive of pamphlets, about 350 volumes are now deposited in the museum for reference, and in addition to these the reading-room is supplied with periodical publications and reports.

It will thus be seen that the Parkes Museum is fairly established. Owing to the limited means at the disposal of the Committee the museum is only opened to the public free on Tuesdays, Thursdays, and Saturdays, from 10 to 2 o'clock. This is perhaps a convenient time for architects, doctors, and other professional men, but it would be more completely supplying a public want if so beneficial an institution were opened during the evening, or at some such time when artizans and those actually engaged in building construction and sanitary work, might best avail themselves of the opportunities for gaining that enlightenment and knowledge which frequent and studious inspections of the contents of this museum of Hygiene would naturally afford them.

NOTES

THE building of the U.S. National Museum is approaching completion at Washington. It stands in the close neighbourhood of the Smithsonian Institution, but is of so different a style of architecture that it will not seem to dwarf the older structure by comparison. The area required for the museum, *Science News* informs us, is 327 feet to a side; in all, about 100,000 square feet, which is a somewhat greater space than the "Government Building" covered at the Centennial Exhibition; but is intended to be capable of holding and satisfactorily showing at least twice as many objects. The building is a square, with ornamental towers at the corners. It rises by a succession of clerestories to a centre surmounted by a dome. The height of the roof at the outer edge is 27 feet; the central room covered by the dome is 90 feet high. Exclusive of the towers, there are seventeen rooms in the interior, and of these apartments five are 65 feet square, four are 65 by 52, four are 91 by 52, and four are 101 by 65; the last mentioned being 45 feet high, and the rest of lesser heights except the one under the dome. The corner towers contain about 160 rooms, of which sixteen are 30 feet square, sixteen are 30 by 20, and the remainder are about 13 feet square, but arranged in suites of twos and fours. The larger of the tower-rooms will probably be kept for distinct collections, open to the specialist but not to the public. In the general exhibition rooms, there will be 5,000 feet of dead wall against which cases can be placed, and these if set end to end would extend over 8,000 feet. The total length of shelving in these cases will be 28,000 feet; the area, 74,000 square feet; a visitor who examines all the cases will traverse a circuit of nearly three miles. The museum will contain all that the Government displayed at Philadelphia; all the exhibits of foreign countries which were presented to the United States at the close of the Centennial show; the accumulations of the national surveys; the collections which are now overrunning the Smithsonian and the Patent Office, and a very extensive and complete exhibit of our fishing industries. Not a particle of wood will be used in constructing the building; hence it will be fireproof. It is to be warmed by steam in winter, and perhaps will be cooled in summer, so as to give a uniform temperature throughout the year.

THE death is announced of Dr. Eduard Fenzl, of Vienna, Professor of Botany and director of the Imperial Botanical Cabinet. Dr. Fenzl was a member of the Vienna Academy of Sciences and vice-president of the Vienna Horticultural Society. He died on September 29 last at the age of seventy-two years.

AT Baden-Baden the German geologists held their meeting after that of the German Association was over, viz., on September 26 and 27. Prof. Knop, of Karlsruhe, presided. There were some sixty members present from all parts of Germany and Austria. Mineralogical, geological, and palæontological papers were read by Professors Beyrich, Knop, Beneke, Häusler, Baumhauer, Eck, von Mojsisovics, and Tschermak.

THE American Association have selected Boston for their meeting next year, a pressing invitation from Sau Francisco

having meantime been declined. The president at the Boston meeting will be Prof. Morgan, of Rochester.

M. OTTO STRUVE, as our readers probably know, was recently in the United States, when he visited the works of Mr. Alvan Clark, the celebrated optician, and ordered an object-glass of 80 cent. diameter for Pulkowa's Observatory. We are informed that in consequence of that visit, Mr. Clark has gone to Paris in order to have the glass cast at M. Feil's works, rue Lebrun.

THE opening of the Practical School of Astronomy, of which we have already spoken, will take place very shortly at the Paris Observatory. The delay which has occurred has been occasioned merely by the absence of M. Ferry, who has been travelling through the whole of the provinces advocating in favour of Article 7 of his Education Law.

A NUMBER of scientific men are organising a Geographical Society in Algiers. The number of subscribers is not less than 200, and a general meeting has been convened for electing the officers of the Association. The success of that movement has led others to attempt the foundation of an Algerian Society for the Advancement of Science; but this is not likely to be successful, the attempt being premature.

PROF. PIAZZI SMYTH has been advocating the erection on one of the heights of Cyprus of a sort of Imperial Observatory, for which he thinks its clear atmosphere and sunny climate peculiarly adapted. He wonders how the British astronomers can exist at all in this cloudy and smoky climate.

THE following is the title of the essay to which the Howard Medal of the Statistical Society will be awarded in November, 1880. The essays to be sent in on or before June 30, 1880:—"The Oriental Plague in its Social, Economical, Political, and International Relations: Special Reference being made to the Labours of Howard on the Subject." The Council have decided to grant the sum of 20*l*. to the writer who may gain the "Howard Medal" in November, 1880.

THE Trustees of the British Museum are making arrangements to light the reading-room by means of the electric light. Waterloo Bridge has been lit up by ten electric lamps on the Jablochkoff system.

FROM a number of the *Otago Witness* which has been sent us we are pleased to see that science has not a few enthusiastic disciples in New Zealand. Prof. Black, of Dunedin, we are told, delivered the fifth lecture of the course in the chemistry lecture-room on July 12. For want of sufficient accommodation, the lecture was delivered twice—to the far-distance teachers, from 12.30 to 4 P.M.; and to the teachers resident in Dunedin and suburbs, from 5 to 9 P.M. As usual, the lecture-room was full on each occasion, about 180 teachers—80 of whom were ladies—being in attendance. Many of these came from a great distance. One gentleman came from Ngapara, 93 miles north from Dunedin; another from beyond Clinton, 75 miles south of Dunedin—thus bringing together teachers whose schools are 168 miles apart. About 20 of the teachers who attend these classes come more than 60 miles—from Lawrence, Oamaru, and beyond Balclutha. Over 60 of them come more than 30 miles. "Altogether, we believe," the *Witness* states, "the distances travelled to attend a course of lectures is quite unprecedented in any country, and our teachers are to be greatly commended for the interest which they take in the subject."

THE first meeting of the session of the Society of Medical Officers of Health will be held at 1, Adam Street, Adelphi, to-morrow at 8 P.M., when an inaugural address will be delivered by the president, Dr. J. S. Bristowe.

PROF. CORFIELD'S Introductory Lecture to the Ladies' Class of Hygiene and Public Health at University College will be delivered on Wednesday, October 22, at 3 P.M. The course will be continued on succeeding Wednesdays at the same hour.

IN the *Revue Scientifique* of September 27 is an interesting paper by E. B. Renault on the Comparative Structure of some Stems of the Carboniferous Flora.

AT Belgrade there were two shocks of earthquake on Friday and one on Saturday; on Saturday a shock was felt at the Roumanian town of Turn-Severin on the Danube.

DR. J. E. TAYLOR'S Winter Course of Lectures in connection with the Ipswich Museum will be on Flowers and Fruits. The average attendance at these lectures is 500 people, chiefly of the working class.

THE third part of Dr. Dodel-Port's excellent "Atlas der Botanik" is to be published within a few days. It will contain: (1) *Ulothrix zonata*; the most important points in the whole development of one of the lowest sexual chlorophyll *Algæ*. This treatise is an abstract of a monograph which the author published some years ago and which excited considerable interest at the time. The original treatise was noticed in these columns (vol. xv. p. 511). (2) *Polysiphonia subulata*; the fertilisation of a red sea-weed by animalcules, of which we gave an abstract a few numbers back (vol. xx. p. 463). (3) *Schizomycetes*; different types of putrefaction- and infection-fungi (with *Spirochæte Obermeieri*, the contagium of a certain typhoid disease). (4) *Bacterium anthracis*; the whole development of the carbuncle fungus according to the researches of Prof. Nägeli, of Munich, and of the author himself. (5) The development of the prothallium of the fern genus, *Aspidium*, from the spore to the formation of embryos. (6) *Cycas circinalis* and *C. revoluta*; female plant, female flower, carpel and fruit of the lowest flowering plant. Besides his "Atlas der Botanik," which involves years of hard work, Dr. Dodel-Port is about to publish a profusely illustrated work, "Bilder aus dem Pflanzenleben," which is written in popular language and is intended to bring the most interesting and most important questions of scientific botany before a larger public. The first part of this new book is to appear early in November.

AN interesting surgical case was recently reported by M. Larrey to the French Academy of Medicine. A young carpenter received a blow from an axe on his right foot. The big toe was almost completely detached; it was held merely by a small thread of skin, and hung on the side of the foot. Dr. Gavey, who was at once called in, detached the toe completely, then after having washed it and the wound on the foot, he adapted the two surfaces as well as possible one to the other, and made them hold together by means of strips of lint soaked with collodion and placed along the toe. When the collodion had set another strip was wound round. Further, an apparatus was used to keep all the parts of the foot in perfect immobility. Twelve days after, the dressing gave no bad smell, the patient was very well, and desired to go out, and twenty-four days after the accident the cicatrisation was perfect.

WE are sure our readers would welcome the very simple scheme proposed by Mr. Clifford Eskell for the giving of receipts by the Post Office officials for the posting of letters or other documents, at the cost of one farthing each. Mr. Eskell has forwarded us specimens of the "posting proofs" proposed by him, and they seem to us both simple and well adapted for their purpose. Some such arrangement as this would often save a world of trouble, and we trust that means will be taken to induce the Post Office authorities to give it a fair trial.

THE Smithsonian Institution, we learn from *Science News*, has lately added to its series of Check-Lists, one by Prof. A. E. Verrill, which originated in the useful purpose it would serve in the scientific work of the U.S. Fish Commission. It is entitled

"Preliminary Check-List of the Marine Invertebrata of the Atlantic Coast from Cape Cod to the Gulf of St. Lawrence." The paper, however, is not a complete catalogue. The whole of the groups Entomostraca, Nematoda, Rotifera, Trematoda, Cestoda, Acanthocephala, most of the sponges, and the protozoans, have been omitted. This is due to the fact that Prof. Verrill considers our knowledge of them too inadequate to justify a place in this check-list. The amphipods are represented by a blank, and the annelids leave room yet for many additions. Moreover, species not found at a depth of less than 200 fathoms are omitted, and likewise those from the Grand Banks of Newfoundland, which will be the subject of a separate publication. Despite these limited conditions of the work, a surprising number of marine invertebrates is catalogued—no less than about 11,000 species. Various signs and letters indicate the geographical distribution of many of the rarer species, and add value to the paper, which serves, among other uses, as a partial record of the zoological results of the Fish Commission's dredgings. As yet only a small "author's edition" has appeared; but a revised issue of a large number of copies will soon be sent out.

ON October 1 a double ascent, which produced some sensation at Paris, was made at La Villette gas-works. The balloons *European*, 650 cubic metres, carrying two aëronauts, and *Observatoire Aérien*, 350, carrying one, were sent up connected by a telegraphic wire of 120 meters weighing 1,500 grammes, and susceptible of a resistance of 15 kilogrammes without breaking. One aëronaut in each balloon carried round his body an inversion element and a Morse telegraph. Telegraphic signals were exchanged successfully during the connection, which lasted for thirty-three minutes, in spite of the differential motions of the air, which was in a state of rather great agitation. As it was very easy for the aëronauts to keep up conversation, no regular messages were sent through the wires. Other experiments will be made shortly with telephones, and a kilometre wire weighing 27 kilogrammes, and resisting a traction of 100 kilogrammes without breaking. In the experiment of October 1 the rope was disconnected only, because the aëronaut of the *Observatoire Aérien* expressed the wish to ascend to a greater height. As soon as the balloons were separated, each of them parted in a different direction. One of them landed in the north-east of Paris, and the other in the north-north-east. The separating force can be valued to the tenth part of the propulsion. The idea of sending up a couple of balloons connected by a telegraph or telephone wire must be attributed to M. Jovis, who was the captain of the *European*. M. Henry Ménier, the maker of telegraph wires at the Grenelle Works, has long entertained the idea of using the differentiation of velocity of each balloon with the current of air in which it is immersed for steering them with sail or rudder. He is to construct for this purpose a special cast-steel wire, susceptible of great resistance. It remains to be seen what is the practica bility of these and other schemes; but the fact of sending up two balloons so connected, and of keeping them in connection at will, unquestionably opens up a large field for future observations and scientific explorations which must be noticed.

MR. JAMES PATON, Curator of the Kelvingrove Museum, Glasgow, has prepared an interesting report of an official visit he paid recently to the museums and art galleries of Holland and Belgium. All the principal cities of these countries, he shows, are provided not only with magnificent art galleries, but with excellent scientific and technical museums, presenting an enviable contrast to most of the large cities of this much wealthier country. Mr. Paton reads the citizens of Glasgow a lesson which might well be taken to heart by other towns both in England and Scotland. "In point of population, wealth, and resources," he concludes, "not one of the towns alluded to in this report approaches the city of Glasgow. Taken altogether, their industries are fewer, less diversified, and less extensive, and their access to and command of markets, and consequently their opportunities for commercial development, are not equal to those enjoyed by our citizens. With less ability to maintain their great public institutions, and with less urgent necessity for them, on account of the limited industrial sphere of their inhabitants, these cities have put forth efforts on a scale which, if equalled in Glasgow, could not fail to have a most marked effect on the industrial standing of the city, at once elevating and refining the taste, stimulating thought and research, and suggesting new inventions and combinations. These institutions raise the whole mass of the population to a higher level, and they broaden and deepen the fertilising stream of industrial activity."

MR. EDWARD WHYMPER is about to issue a condensed and cheaper edition of his "Scrambles Amongst the Alps" under the title of "The Ascent of the Matterhorn." It will be published by Mr. Murray. Among other forthcoming books to be published by Mr. Murray we notice the following:—"A History of Ancient Geography," by E. H. Bunbury, F.R.G.S., with index and maps; "The River of Golden Sand," being the narrative of a journey through China to Burmah, by Capt. Wm. Gill, R.E.; in two volumes, with a map and illustrations; "A Lady's Life in the Rocky Mountains," by Isabella Bird; "A Sketch of the Life of Erasmus Darwin," by Charles Darwin, F.R.S.; with a Study of his Scientific Works, by Ernest Krause, translated by W. S. Dallas.—Messrs. Crosby Lockwood and Co. have nearly ready for publication a "Treatise on Metalliferous Minerals and Mining," by D. C. Davies, F.G.S., Mining Engineer. The book will be illustrated with numerous wood engravings.—Mr. David Bogue has in the press a Manual of the Infusoria, by Mr. W. Saville Kent, F.L.S. The volume will comprise a descriptive account of all known Flagellate, Ciliate, and Pentaculiferous Protozoa, and will be accompanied by numerous illustrations; it will probably be ready in March next. Mr. Bogue will also publish shortly a work on the "Sphagnaceæ, or Peat-Mosses of Europe and North America," by Dr. R. Braithwaite, F.L.S. This will be illustrated with twenty-nine plates.—Messrs. Kegan Paul and Co. will publish during the ensuing season the following books bearing upon science:—"The Crayfish: an Introduction to the Study of Zoology," by Prof. T. H. Huxley, F.R.S.; with numerous illustrations; "The Brain as an Organ of Mind," by H. Charlton Bastian, M.D., F.R.S.; with numerous illustrations; "The Brain and its Functions," by J. Luys, Physician to the Hospice de la Salpétrière; with illustrations; "The First Principles of the Exact Sciences explained to the Non-Mathematical," by the late Prof. W. Kingdon Clifford; edited by R. C. Rowe, M.A. The above four books are new volumes of the *International Scientific Series*. "Hygiene and the Laws of Health," by Prof. Corfield, M.D.; "Chapters from the Physical History of the Earth: an Introduction to Geology and Palæontology," by Arthur Nicols, F.G.S.; with illustrations; "Matabele Land and the Victoria Falls: a Naturalist's Wanderings in the Interior of South Africa," by C. G. Oates. "An Introduction to the Science of Language," by the Rev. A. H. Sayce, Deputy Professor of Comparative Philology in the University of Oxford; in two vols. —The first volume of Prof. G. G. Stokes' "Mathematical and Physical Papers," reprinted, with additional notes by the author, from the Original Journals and Transactions, in which they appeared, is now nearly ready. It will be published by the Cambridge University Press.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. W. Leekie; five Peregrine Falcons (*Falco peregrinus*) from Scotland, presented by Sir Mathew W. Risley, Bart., M.P.; four Green Tree Frogs (*Hyla arborea*), a

Fire-bellied Toad (*Bombinator igneus*), a Natterjack Toad (*Bufo calamita*), European, presented by Mr. H. A. Macpherson; six Green Tree Frogs (*Hyla arborea*), European, presented by Mr. A. Leipner, F.Z.S.; a Chacma Baboon (*Cynocephalus porcarius*) from South Africa, deposited; two Rendall's Guinea Fowls (*Numida rendalli*) from West Africa, a Javan Peafowl (*Pavo spicifer*) from Java, three Royal Pythons (*Python regius*) from West Africa, received in exchange; two Saffron Finches (*Sycalis flaveola*), bred in the Gardens.

SOME RECENT EXPERIMENTS ON THE CRYSTALLISATION OF SUPERSATURATED SALINE SOLUTIONS [1]

THE history of the various views held by different experimenters on the nuclear action of substances in exciting the sudden crystallisation of a supersaturated solution, has been already so well described by Mr. Charles Tomlinson, Prof. Liversidge, Prof. Grenfell, and others in their several papers upon the subject, that it is unnecessary to enter into any detailed description of their opinions; suffice it to say that they may be divided into two classes: the first holding the opinion that the crystallisation may be excited by the presence of certain fatty, oily, greasy, or other matters in the form of films; the second that the initial cause of the crystallisation must be sought for in the entrance of a particle of the same salt as that which is in solution.

In 1866 M. Gernez indicated that in the case of certain salts the sudden crystallisation might be brought about by the agency of some other salt perfectly isomorphous with the one in solution; thus a supersaturated solution of magnesium sulphate invariably crystallised when crystals of zinc or nickel sulphates containing seven molecules of water in their composition were introduced. Having been for a long time interested in the crystallisation of such solutions, I determined to carry out a large number of experiments upon carefully purified substances which observations have resulted in a confirmation of the views held by Gernez that truly isomorphous substances are active to solutions of each other.

The two methods employed in the experiments may be briefly stated as follows:—(1) The supersaturated solutions of the salts to be examined were placed in small wide-mouthed flasks; and the solutions of the salts employed as nuclei were introduced into very thin glass bulbs plugged with cotton wool, and suspended through a second plug of cotton in the neck of the flask, in a manner such as is indicated in Fig. 1. (2) A large number of the experiments were also performed by using, instead of the bulb tube for the introduction of the salt employed as nucleus, a tube bent as a siphon, thus ∩J, and like the bulb tube passing through cotton wool plugs in the necks of the flasks; the whole arrangement when complete being as represented in Fig. 2. To perform an experiment the solution in the bulb or in the siphon tubes was crystallised, and after a short time these tubes were gently lowered into the solutions in the flasks and the results observed. When the bulb tubes were used they were gently broken against the bottom of the flask, the contained crystals being thus brought in contact with the solution. To show that the disturbance produced by this breaking had of itself no exciting action on the solutions in the flasks, corresponding experiments were made with bulbs containing clean pieces of glass, when no crystallising action took place, showing that the mere disruption of the solution did not cause crystallisation. The largest number of experiments were, however, carried out by the siphon tube method, which is perfectly applicable after a little practice in the introduction of the tubes. The substances employed were in all cases carefully examined to ensure their purity.

With magnesium sulphate ($MgSO_4 . 7H_2O$) as a supersaturated solution, it was found that the other sulphates of the same group of metals, namely, those of zinc, nickel, cobalt, and iron, were immediately active in causing the crystallisation of the magnesium solution when they possessed an identical composition with it, as represented by the general formula ($M''SO_4 . 7H_2O$), M representing the different metals. When these salts contained only six proportions of water crystallisation is sometimes induced, but in this case it is of an entirely different nature, the deposition being slow and gradual. In connection with this group of salts interesting results were obtained with the double salt potassio-magnesic sulphate ($MgK_2(SO_4)_2 . 6H_2O$), crystals of which, although possessing the elements of magnesium sulphate, were found inactive to a solution of that body. In the case of supersaturated solutions of sodium sulphate ($Na_2SO_4 . 10H_2O$), the bodies sodium selenate ($Na_2SeO_4 . 10H_2O$), and sodium chromate ($Na_2CrO_4 . 10H_2O$), each analogous in form and constitution to the sulphates but containing the elements selenium and chromium instead of sulphur, were found capable of exciting crystallisation in solutions of the sulphate.

Experiments were also performed upon supersaturated solutions of potash alum ($AlK(SO_4)_2 12H_2O$), with crystals of iron and chromium potash alums, bodies agreeing in form and constitution with common alum, but containing chromium or iron in place of the metal aluminium. These bodies were found invariably active in exciting the crystallisation of the common alum solution. As alum crystallises in beautiful octahedral crystals some experiments were made to see how far the mere shape of the crystal could render it active in exciting the crystallisation; and for this purpose cubes of copper pyrites and octahedra of magnetite, both belonging to the same crystalline system as alum but having a different chemical structure, were employed. When these substances in a perfectly clear condition were placed in the alum solutions no sudden crystallisation was produced, showing that mere form alone is inactive in exciting this kind of crystallisation. Crystals of hydric disodic arsenate ($Na_2HAsO_4 . 12H_2O$) were also found active in the case of the isomorphous hydric disodic phosphate, containing phosphorus instead of arsenic, but otherwise analogous in form and composition. In connection

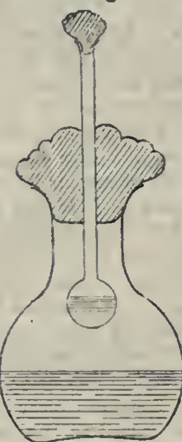


Fig. 1.

Fig. 2.

with this latter salt it is worth noting that when the hydric disodic phosphate is heated to convert it into sodium pyrophosphate ($Na_4P_2O_7$), this substance is no longer active to a supersaturated solution of the disodic salt. At the same time corresponding experiments were performed on the supersaturated solutions of magnesium sulphate, alum, &c., with substances of dissimilar form and chemical constitution; these bodies, however, invariably yielded negative results, being incapable of exciting the sudden crystallisation of the solutions.

Experiments carried out upon mixtures of similarly constituted and dissimilar bodies, yielded some interesting results. The substances employed were mixtures of the similarly constituted sulphates of magnesium and nickel, and the dissimilar sulphates of magnesium and sodium; experiments were also made with sulphates of nickel and sodium. In the case of these mixtures it was observed that two results might occur:—(A) The nucleus might remain growing in the solution without causing immediate crystallisation; or (B), Crystallisation might be induced at once on the addition of the nucleus; the deposition of the salts, however, differs according to the nature of the substances employed.

In the case of the dissimilar bodies, magnesium or nickel sulphates with sodium sulphate, it was found that a nucleus of either sulphate when gradual crystallisation took place, slowly increased by a deposition of the substance of the same nature as the nucleus added; and that even with the rapid crystallisation of dissimilar bodies the salt deposited consisted essentially of the substance of the same nature as the nucleus added.

[1] Abstract of a paper read before the Chemical Society on March 6, 1879.

With mixtures of isomorphous salts, however, the results were different. In these cases sudden crystallisation on touching with a nucleus producing a separation of both the sulphates apparently always in the proportions in which they existed in the solution. When gradual crystallisation took place with the sulphates of nickel and magnesium the nucleus increased by a deposition of the least soluble salt independent of the nature of the nucleus added. It may be seen therefore from these experiments that truly isomorphous bodies, that is, substances not only possessing the same form but also an identical chemical structure, may be regarded as active nuclei in exciting the sudden crystallisation of supersaturated solutions of each other. I hope shortly to extend the observations upon supersaturated solutions of mixtures, and of compound salts, employing their different constituents as nuclei, as I think by such experiments some light may be thrown upon the relations between these constituents when associated together in solution. There are, however, very few true double salts of which it is possible to obtain thoroughly supersaturated solutions.

JOHN M. THOMSON

ON THE EARLY STAGES OF THE CÆCILIANS

THERE are few groups of vertebrates respecting whose life-history and development so little is known, as the curious snake-like amphibians forming the order *Peromela*, and usually known as Cæcilians. In all the ordinary zoological text-books in use in this country, the early stages of these animals are either left entirely unnoticed, or, at most, allusion is made to Johannes Müller's classical discovery of gill-slits in the young of *Epicrium glutinosum*. Even Prof. Huxley, in his article on the Amphibia in the first volume of the "Encyclopædia Britannica," published in 1875, after an allusion to Müller's discovery, states:—"It is to be regretted that nothing is known of the development of the Peromela" (*loc. cit.* p. 770).

This being the case, it may be useful to call attention to two papers on the development of the Cæcilians, by Dr. Peters, the eminent German naturalist, read by him before the Royal Academy of Sciences of Berlin, and published in their *Monatsberichte*, as their contents seem to be unknown to, or overlooked by, the bulk of English zoologists. The first of these bears the date of January, 1874, the second was read eighteen months later (July 19, 1875). In the first of these Dr. Peters, after noticing the discovery by Müller of gill-slits in *Epicrium*, and its subsequent confirmation by himself (*cf. Monatsbericht*, 1864, p. 303) continues, "it was therefore extremely interesting to me to learn from Prof. Wrzensniowski of Warsaw, who last summer honoured me with a visit, that some years ago the naturalist-traveller Constantin Jelski had sent him from Cayenne a gravid *Cæcilia*, which after its capture had given birth to a young one, and had contained in its uterus several full-grown embryos. Herr Wrzensniowski has now sent me for examination three of the young ones, and the old animal, referable to *Cæcilia compressicauda* (Dum. and Bibr.), and has given with them the following notes, part of which are extremely interesting." These notes are extracted from a letter of Jelski's, dated from Cayenne, November 12, 1866, to Herr Taczanowski, the well-known Polish zoologist, in which he gives his account of an expedition to East Guiana, to a plantation called "Bon Père," belonging to a M. Lalanne, from which he had just returned. After narrating the method of fishing by means of nets adopted, and the great abundance of fish, Jelski continues—"'In the course of the hunt, the negro who was frightening the fish away from the bank, suddenly uttered a loud cry: we all saw something that looked like an electric eel swimming about with worm-like movements just under the surface of the water. M. Lalanne and I held back the negro, who was about to cut the animal into bits with his sword, the net was hauled up, and the creature landed. We all thought it was an eel, but on closer examination decided that it was a gigantic water-worm. I put the creature into a special vessel, and as I had already fish enough, and did not hope to obtain any others, went home. As I was taking this problematical creature out of the vessel, to put it into the calabash, I saw two of them instead of one. The old one had produced a young one. After I had laid the old one on the table, I examined it more closely; it exhibited very slow, tremulous, slight movements. Shortly afterwards I found it in true convulsions. I perceived that it was about to produce a second young one. I placed it in spirit, so as to convince people of its being viviparous. Membranes (*Häute*) were ejected together with the first young one.' Herr Wrzensniowski adds—'After the receipt of the animal, I dissected it myself, and found in the oviduct five young, which I at once extracted, and two of which I send you together with the one that was born in Cayenne. All these examples that were removed from the oviducts were remarkable for a membranous outgrowth on the necks which was very easily torn off, and left a transverse linear scar, as in the specimen born in Cayenne, so that only a single specimen has retained this outgrowth till now. In the uterus I perceived nothing else noteworthy; the embryos lay in a dilatation of both oviducts, just as they now are in the spirit, without being covered by any membranous envelopes. I conclude therefore that the membranes, which, according to Herr Jelski, were extruded together with the young one from the oviduct were nothing else than the shed neck-vesicles (*Nackenblase*), which we could not find again in the parcel from Cayenne.'"

"The female forwarded to me, whose oviducts had been removed, was fifty cm. long, and four cm. deep in the middle; its head measured three cm.; of the young ones, the newly-born one, and one of the embryos, had a length of 157 millims., and a depth of twelve millims.; their heads measured eleven millims.; the other was only 136 millims. long and twelve millims. deep; its head was ten millims. They show no trace of the skinny vertical swimming-tail (*Flossensaum*) which both J. Müller and myself found on the hinder ends of the young *E. glutinosum*. But what surprised me much more was that there was no trace to be found of lateral gill-openings, like those which have now been discovered in several young examples of *Epicrium glutinosum*. The head and fore part of the body in all three specimens lay bent back towards the sides of the belly, so that apparently in the uterus this curved part, that is the under side of the head, is closely applied to the body, and the end of the body also seems to have been recurved towards the sides of the belly. From the neck of the one specimen two smooth vesicles, fifty-five millims. long, of irregular shape, and variously constricted, project; on them a blood vessel ramifies, whilst at their narrow transverse base they are connected together, though unfortunately no more can be learnt as to their original position, except that from their flat convex-concave form they are probably closely applied to the body.[1] On the transverse scar, where the epidermis is absent, which these vesicles leave after falling off, on each side a small hole is visible, the lumen of one or two vessels, which are in connection with the aortic arches of their side. These vesicles therefore are external gills, which resemble the bell-shaped external gills which Dr. Weinland discovered in the larvæ which develop in the external dorsal pouch in the female *Notodelphys* (*Opisthodelphys*) *ovifera*, and which he has described so well and thoroughly (Müll. *Archiv*, 1854, p. 457, Taf. xviii., Fig. 5, 6)." After some prefatory remarks on the distribution of the vessels to these bladder-like gills, Dr. Peters concludes:—"In any case, this discovery of a new agreement in the development of the Cæcilians with the other Batrachians is one of the greatest scientific interest, for in fact, not only is there now no doubt that, as in the *Anura*, so also amongst the Cæcilians a different gill-structure (*Kiemenbildung*) obtains, but it can also now be stated with certainty that in these animals also, for which the establishment of a third class or sub-class of Amphibians has even been proprosed, no amnion or allantois are developed, that, in part at least, they are viviparous, and that, at a certain period of the year, they are to be sought for, not in moist earth, but in water. Moreover, it is extremely probable that these animals, which only occur to fishermen rarely, and at a certain season, are not recognised by them, but are in fact shunned and destroyed on account of their ugly and worm-like aspect, and on this account so rarely come into the hands of collectors in their larval state."

In his second paper, read July 19, 1875, Dr. Peters contributes some further notes on the same subject, giving figures illustrating the young *Cæcilia* with its bladder-like gills still *in situ*, as well as the scars left on the neck after the fall of the gills, and the distribution and relations of the great vessels and aortic arches. The bulk of the paper is taken up with an account of the anatomy of the young Cæcilians, but a few additional remarks on other points are given which we here reproduce. "As was there (*i.e.* in his first paper) stated, in this species the embryos at birth are at most three and two-thirds smaller than the mother. It is also known that the young of *Epicrium glutinosum*, in which

[1] This is also very probable from the observations of Weinland on *Opisthodelphys ovifera*, where the bell-shaped gills envelope most of the body.

the lateral gill-slits are still visible, are even larger as compared with the parent animal than is the case in *Cæcilia compressicauda.* According to this, one might almost believe that such a relation in size is universal in the embryo Cæcilians. On the other hand, one might conjecture that a development with external vesicular gills, which obtains only exceptionally amongst the *Anura*, as in *Opisthodelphys* and *Nototrema*, occurred more commonly amongst the Cæcilians. The few observations however which have as yet been made on the other species of Cæcilians do not confirm this. Thus A. Dumeril, in a young *C. oxyura*, 50 millims. long, has found on each side of the neck a branchial cleft, which it is true lies somewhat higher than in *E. glutinosum*, but still proves that in this species no external vesicular gills are developed (*Mem.* Soc. Sc. Nat. Cherbourg, ix., taf., 1 Fig. 8). Further, Prof. Möbius on the occasion of his late visit to the Seychelles, brought back several examples of *C. rostrata* (Cuv.), of very varying sizes (from 35 to 240 millims.) which have neither branchial clefts, nor a swimming-tail, nor do they show the scars on the neck that accompany the vesicular gills. All this leads one to conclude that the development of the Cæcilians, like that of the *Anura*, goes on in very various ways, and that in this field too important discoveries are still to be made. It cannot therefore be too deeply impressed on naturalists who visit tropical countries where Cæcilians are found, to give to this subject their especial attention."

PHILOSOPHY OF THE PUPATION OF SOME BUTTERFLIES[1]

THE comparatively sudden transitions from one state to another in insects, have always excited the keenest interest. The change from larva to chrysalis in those butterflies known as *suspensi*, and which in the chrysalis state hang from the tip of the body, has, perhaps, been looked upon as the most wonderful. The preliminary acts in the performance have been pretty well observed and described by various authors since the days of Vallisnieri. The larva hangs by the anal end, turning up the anterior part of the body in a more or less complete curve, and the skin finally splits from the head to the front edge of the metathoracic joint, and is worked back in a shrivelled mass towards the point of attachment. Now comes the critical feat which has most puzzled naturalists, viz., the independent attachment of the chrysalis and the withdrawal from, and the getting rid of, the larval skin which such attachment implies.

Réaumur explained it in 1734 by the clutching of the larval skin between alternate sutures of the soft joints of the chrysalis; and his happy and circumspect account from observations made on *Vanessa urticæ* has formed the basis for subsequent accounts; no one obtained a deeper insight into the philosophy of the act until, some two years since, Dr. J. A. Osborne, of Milford, England, discovered that a distinct membrane is concerned in it. In casual observations of the process I had long become convinced that the popular accounts were crude and inaccurate, and I had preserved specimens in the act of transforming, for future study; but the philosophy of the change cannot be satisfactorily made out from alcoholic specimens alone, nor from the study of one species. The present paper is based on observations made on species belonging to more than a dozen genera, the conclusions having been partially presented last June to the Philosophical Society of Washington.

The body of the larva is composed (exclusive of the head) of twelve segments or joints, *and a sub-joint.* It is with this sub-joint that we have here to deal, for to it beneath the rectum are appended the anal pro-legs, and above this is the anal plate.

If we carefully examine the anal plates of the larvæ of the true *suspensi*, we shall find that while they differ in form they have one feature in common, viz., the being furnished dorsally and posteriorly with numerous short spines and points generally retrorse, or so placed that the larva can make use of them in suspending. These special spines on the anal plate are only fully developed after the last larval moult, being more or less obsolete in the earlier stages, and they are also under muscular control. Even in the *succincti*, where, as a rule, the anal plate is not specialised, spines are, nevertheless, sparsely found, especially on the border.

All writers whom I have consulted speak of the larval suspension being due to the entanglement of the hooks of the anal pro-legs in the silk, and do not mention the use of the anal plate, for which the hillock of silk is sometimes spun in special form.[1]

The normal form may be likened to that of an inverted settee, or shoe, or to a ships-knee, and one of the most interesting acts of the larva, preliminary to suspension, is the bending and working of the anal parts in order to fasten the back of the plate to the inside of the back of the settee, while the crotchets of the legs are entangled in the more flattened position or seat. In some cases (as in *Danais*) the hillock of silk is more elongate, and the spines of the truncate plate mostly occur around the lower margin and even beneath it, so that in fastening them the larva seems to be drawing the silk up the rectum. In other cases (as in *Euptoieta*) the plate, in addition to the spines, has a prominent tubercle on each anterior outer border well calculated to lock securely into the silk. After suspension, and as the fluids gravitate anteriorly, the silken hillock becomes more conical (the threads being loosely spun and elastic) and the hooks both of the plate and the pro-legs hang more loosely from it.

In the final getting rid of the larval skin and attachment of the chrysalis there are concerned—

1. Certain factors belonging to the larva and cast off with its skin. 2. Those belonging to the chrysalis; and to intelligibly explain the process it is necessary to more fully characterise and homologise these parts than has hitherto been done.

In the former category, in addition to the natural adhesiveness of the moist, mucous, and membranous corium,[2] there are three physiological factors concerned: (1) the *tracheal ligament*, or the shed tracheæ from the last or ninth pair of spiracles which uniformly become blind or obsolete in the chrysalis; (2) the *rectal ligament* or shed intestinal canal; (3) the Osborne or retaining membrane (*membrana retinens*), which is but a stretched part of the membranous corium that accumulates around the rectum and in the anal pro-legs.

In the second category we have the structural features of the chrysalis. These are, first, the *cremaster* proper, which is the homologue of the anal plate of the larva, and the form of which is foreshadowed in that of said anal plate. This cremaster assumes a great variety of different forms, but in general may be said to be a tapering piece more or less incurved ventrally, and having the ventral and dorsal margins thickened or ridged, and these ridges may be respectively called the *ventral* and the *dorsal cremastral ridges*. This cremaster is surmounted at the apex and sometimes along the ventral ridges by what may be called the *cremastral hook-pad*, thickly studded with minute but stout hooks, which are sometimes compound or furnished with barbs very much as are some of our fishing-hooks, and which are most admirably adapted to the purpose for which they are intended.

Secondly, we have the sustainers (*sustentores*), two projections which homologise with the soles (*plantæ*) of the anal pro-legs, and which take on various forms, but are always directed forward, so as to easily catch hold of the retaining membrane. In the yellow butterflies (as *Callydrias*, *Terias*, *Colias*), where the body of the chrysalis is so thrown back that mere projecting tubercles would not suffice, we find them transformed into actual hooks; while in some of the *succincti* they are little more than a thickening of the anterior margin of the sub-joint. In all lepidopterous pupæ these remnants of the anal pro-legs are more or less indicated, while in certain moths (*Pterophoridæ*) where the pupa is partly suspended, they are, as in the *Nymphalidæ*, covered with long hooks similar to those at the tip of the cremaster.

Thirdly, we have what may be called the *sustentor ridges*, usually connected with the sustainers, embracing them on the outside, and extending backward to the inside of the ventral cremastral ridges, and sometimes, as in *Paphia* and *Limenitis*, forming quite a deep notch, which doubtless assists in catching hold of the larval skin in the efforts to attach the cremaster.

[1] Abstract of a paper read before the American Association for the Advancement of Science, by Prof. C. V. Riley.

[1] It is an interesting fact in this connection that Roesel, who has never had any superior as a delineator of insect larvæ, makes the Nymphalids in his figures all suspend to an elongate conical piece of silk apparently issuing from the anus, with the legs invariably free and in no instance hooked. It is evident, however, from his text, that he was not aware of the use of the anal plate, and since he speaks of the larvæ attaching themselves by the bind legs or extremities, it is equally evident that his figures do not correspond with the text, while the freedom of the legs in his figures is, of course, an error

[2] What is here termed the *corium* is the membranous layer between the separating larva skin and the forming chrysalis. If, as recent investigations seem to show, it is only the outer half of the dermal layer of the skin which is cast off in the exuviation of invertebrates, and not the whole skin with its three layers, then this membrane is developed between the splitting parts of said outer layer, and is not, strictly speaking, the *corium*.

These sustentor ridges are homologous with the limb of the anal pro-legs and the exposed edge with the posterior border of said limb. They vary much in form, and may be more or less obsolete.

Fourthly, between them is what may be called the *rectal piece*, consisting of a piece more or less well marked and elevated, especially around the closed rectum.

It is principally by the leverage obtained by the hooking of the sustainers in the retaining membrane, which acts as a swinging fulcrum, that the chrysalis is prevented from falling after the cremaster is withdrawn from the larval skin. It is also principally by this same means that it is enabled to reach the silk with the cremastral hook-pad. Yet the rectal ligament plays a most important part, and in some species a more important part even, in my estimation, than the membrane itself. The tracheal ligaments which, from a study of specimens plunged in alcohol when the larval skin was about half shed, I was at first inclined to believe important auxiliaries, are, I am now satisfied, of very little if any service in most cases. The rectal ligament is a constant physiological factor, and its importance cannot be ascertained by attempts to sever the membrane at the critical moment, because in such attempts the ligament is more or less drawn out beyond the power of the sphincter muscles in the chrysalis to control it.

Dissected immediately after suspension, the sub-joint of the larva will be found to be lying, especially between the legs and around the rectum, in an abundance of translucent, membranous material. An hour or more after suspension the end of the forming chrysalis begins to separate from the larval skin, except at the tip of the cremaster. Gradually the skin of the legs and of the whole sub-joint stretches, and with the stretching the cremaster elongates, the rectal piece recedes more and more from the larval rectum, and the sustentor ridges diverge more and more from the cremaster, carrying with them, on the sustainers, a part of the soft membrane. If a larva be carefully dissected at this stage, the forming membrane may be raised with the point of a needle, and stretched so as to show its connection with the rectal ligament; or it may be lifted entirely from the retainers, when, by its elasticity, it contracts, and becomes more or less fully absorbed in the rectal ligament. It is at this stage that the strength of the latter may be fully tested, and if the chrysalis, flayed from the larval skin, and freed from the retaining membrane, be grasped in the neighbourhood of the rectum, so as to supply the natural holding power of the sphincter muscles, the rectal ligament will sustain, as I have abundantly proved, at least ten or twelve times the weight of the chrysalis; while it will support, if held by the larval skin, several times the weight of the chrysalis before separating therefrom. In brief, the retaining membrane is that part of the inner larval skin surrounding the pro-legs drawn down by the sustainers, and always intimately connected with and forming but a branch of the rectal ligament. When extended from its attachments, as when the chrysalis rises to the silk, this membrane dries, and in the cast-off larval skin retains more or less perfectly the stretched form. If the corium of the larva be thick and strong, as in *Vanessa*, the dried membrane will be broad, with two indentations where it was held by the retainers; if the corium be more delicate, as in *Danais*, *Paphia*, or *Apatura*, the dried membrane will be more forked, showing how the retainers have acted upon its elasticity. In every case, however, it shows, under the microscope, the longitudinal folds and creases incident to the stretching, and, compared to the rectal ligament proper, it seems to lose importance as it is less needed; for the *succincti* will generally attach when it is severed or loosened from the retainers, while in *Apatura* (at least as exemplified in the North American species), which combines the peculiarities of both the *succincti* and *suspensi*,[1] it does not become specialised, and the chrysalis seems to rely almost entirely on the rectal ligament, assisted by the partial holding of the delicate larval skin, not only between what is left of the sustainers and the ventral posterior margin of the twelfth joint, but between the ventral sutures of this last and the preceding joint. And here I would remark, in conclusion, that the ventral borders of two or three of the joints preceding the subjoint are, in most chrysalids which I have studied, so hardened that the larval corium is actually grasped between them and the deep sutures made in contracting. In some instances (especially in some species of *Papilio*) the posterior border of the twelfth joint is produced into a medial transverse ridge fully as prominent as that formed by the sustainers, which here are flattened and coalesce; so that the sutures of some of the terminal joints in the chrysalis do subserve the purpose ascribed to them by Réaumur, but in a somewhat different way.

[1] The larva of *Apatura* attaches horizontally, making the front pair of abdominal pro-legs answer the purpose of the girth; but in the shedding of the skin this attachment is severed, and the forming chrysalis assumes the perpendicular position, and in the withdrawal and attachment of the cremaster it acts as the true *suspensi*.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Oxford *University Gazette* of October 10 contains counsel's opinions on the proposed faculty of Natural Science at Oxford. It has been proposed that the University should, by statute, establish a new faculty, under the name of "The Faculty of Natural Science," should grant degrees of Bachelor and Master in that faculty, and should give to Masters of Natural Science all the rights and privileges which are now enjoyed by Masters of Arts, so making them Members of Convocation (the governing body of the University), and enabling them to vote for the members returned to Parliament by the University. Mr. Horace Davey is of opinion that the University may create a new faculty in science, or (which comes to the same thing) may sever one of the sciences or philosophies formerly comprised in the Faculty of Arts, and may make it into a new faculty, and grant degrees therein. Such a severance was anciently made in the case of grammar, rhetoric, and music. But Mr. Davey believes that the University has no power to confer upon graduates in a new natural science faculty the rights which now belong to Masters of Arts, and the degree of Bachelor or Master of Natural Science would not make the holder a Member of Convocation. This difficulty Mr. Davey suggests, might be avoided by the University conferring the degree of Master of Arts on any person obtaining the corresponding degree in the new faculty.

The new chemical laboratories at the Oxford University Museum will be opened for students this term. The chemical department has now for many terms been overcrowded, and the new buildings will not only afford ample space for beginners and pass-men getting up their "simple salts," but contain rooms set apart for special work and fitted with the best appliances under the careful superintendence of Mr. W. W. Fisher, Aldrichean Demonstrator.

The new chemical laboratory at Balliol College will be opened this term under the superintendence of Mr. H. B. Dixon. Balliol and Trinity Colleges have combined to equip and maintain this laboratory, and a physical lecture room for the use of their own students.

At the University Museum Prof. Odling will lecture, this term, on Organic Chemistry; Mr. Fisher will lecture on Elementary Organic, and Mr. Donkin on Elementary Inorganic, Chemistry. Prof. Clifton will lecture on Elementary Electricity, and Prof. Story-Maskelyne on the Use of the Goniometer. Prof. Prestwich gives a course on two afternoons a week, on the Palæozoic Rocks, at the Museum, and Prof. Lawson will lecture on Vegetable Histology, at the Botanic Garden. Rev. C. Pritchard, Savilian Professor of Astronomy, will give practical instruction at the University Observatory, on fine evenings during the term; he will also continue giving public lectures on the history of astronomy. Dr. Rolleston will lecture on Circulation and Respiration, and practical instruction in anatomy and physiology will be carried on in the laboratory, under the superintendence of Mr. Robertson, Mr. Jackson, and Mr. Poulton. Mr. Barclay Thompson will lecture on the Anatomy of the Amphibia, at the Museum. At Christchurch Mr. Vernon Harcourt will give a course of lectures on the Elements of Chemistry, and Mr. R. E. Baynes will give a course on Mechanics.

At Magdalen College Laboratory Dr. Pike will lecture on Chemistry, and Mr. Yule and Mr. Chapman on Biology.

Exeter College has lost the valuable services of Prof. Lankester. Mr. Lewis Morgan, formerly house surgeon at the Radcliffe Infirmary, will carry on instruction in the biological laboratory of the College.

In the month of November there will be an election at Balliol College to a scholarship on the foundation of Miss Hannah Brakenbury, "For the Encouragement of the Study of Natural Science," worth 80*l*. a year (55*l*. and tuition free), tenable during residence for four years. There is no limit of age, but members of the University must not have exceeded eight terms from

matriculation. The examination will begin on Friday, November 21, at 10 A.M. Papers will be set in (1) Mechanical Philosophy and Physics; (2) Chemistry; (3) Physiology. Candidates are not expected to offer more than two of these subjects. There will be a practical examination in one or more of the above subjects.

The Science Scholarships at Exeter College have been awarded to Mr. Alfred Evans, of Aberystwith College, and Mr. Percy Morton, of Manchester Grammar School. *Proxime* Mr. Makinder. The examination was held in Biology, Chemistry, and Physics. An extra scholarship was awarded this year on account of the proficiency of the candidates.

MR. J. J. HUMMEL, who has studied at the Polytechnic School at Zurich, and in the Chemical Laboratory at the Royal Institution, Manchester, under the late Mr. Crace Calvert, and has had wide experience in the art of dyeing at some of the best establishments in the kingdom, has been appointed to the post of instructor in the recently founded School of Dyeing, at the Yorkshire College.

MR. A. J. BENTLEY, M.A., Fielden Lecturer at Owens College, has been appointed Principal of Firth College, Sheffield; we are told there were "forty applications for the post." The college is to be opened next week by Prince Leopold.

ON Wednesday last week, the Rev. J. Percival, M.A., LL.D., who, from the establishment of Clifton College, and for seventeen years, was its popular head-master, and to whose exertions the high position that College has taken among the public schools of the country is mainly due, was presented by the citizens of Bristol with a very handsome and valuable service of plate on his leaving that city for Oxford, he having been elected to the office of Principal of Trinity College, in that University.

SCIENTIFIC SERIALS

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. xii. fasc. xvi.—Periodical variations of tension of atmospheric aqueous vapour and comparative humidity in the climate of Milan, deduced from thirty years' observations at the Brera Observatory, by Signor Schiaparelli.—Further studies on the pelagic fauna of the Italian lakes, by Prof. Pavesi.

THE *Rivista Scientifico Industriale* (No. 16), contains the following papers:—On the power of dry and moist air of absorbing radiant heat, by Prof. Eugenio Cicognani.—On the diffused vapour in the interior of liquids, by Prof. Giovanni Cantoni.—On the thermal and galvanometric laws of electric sparks produced by complete, incomplete, and partial discharges of condensers, by Prof. Emilio Villari.—On the discovery of nitrous acid in the presence of nitric acid, by Dr. Augusto Piccini.—On a new balance spherometer, by Prof. Domenico Surdi.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, October 16.—M. Daubrée in the chair.—The following papers were read:—On the development of the perturbative function, &c. (continued), by M. Tisserand.—On artificial laurite and ferriferous platina, by MM. Sainte-Claire Deville and Debray. Laurite is got by heating to a bright red a mixture of ruthenium and iron pyrites. The sulphur from the pyrites combines with the ruthenium; the sulphide is dissolved in protosulphide of iron, and crystallises, on cooling, in regular octahedra, like natural laurite, or even in cubical crystals, easily separated from the iron by hydrochloric acid. A crystallised alloy of platina and iron is obtained by heating a mixture of platina and pyrites with borax, and treating with certain acids and potash.—Studies on the effects and the mode of action of substances employed in antiseptic dressings, by MM. Gosselin and Bergeron. The imputrescence of 1 gr. of blood is secured by a dose of 0·010 gr. to 0·015 gr. of carbolic acid; with smaller doses the putrefaction is retarded, but not prevented (at least if the dose be not gradually increased). As to the mode of action, the authors consider it is not exclusively by destruction of atmospheric germs (as Lister represents), but by the contact of the antiseptic producing coagulation of albumen. What the authors call the antiseptic alteration of the blood (by addition of a considerable proportion of carbolic acid or alcohol) consists (1) in thickening and yellowing (to the naked eye), and (2) in replacement of the globules by granular masses. This very rapidly-produced imputrescence could not be realised in wounds, the dose of antiseptic being too large; one can merely retard or diminish the putridity, and hope the blood will be absorbed before being altered in septicæmic degree.—On a sporadosideric meteorite that fell on January 31, 1879, at Becasse, Commune of Dun-le-Poelier (Indre), by M. Daubrée. The detonation was heard (about midday) at 20 km. distance. A sound as of a distant train preceded it, and it was followed by rumbling as of thunder. The meteorite (only one) was dug out from about 0·30 m. depth; it must have reached the ground almost vertically, while its trajectory seems to have been from south-south-east to north-north-west. It weighed 2·800 kg., and its form was roughly that of a pyramid with quadrangular base. It seemed to be chiefly formed of peridot and bisilicates (such as pyroxene or enstatite). The metallic grains consisted of nickelised iron, accompanied by tröilite. It belongs to the sub-group of oligosideres in the sporadosideric group.—On the mathematical theory of changes of brightness of double stars, by M. Gyldén.—The mildew, or false American oidium in the vineyards of France, by M. Planchon.—Extract of a letter to M. D'Abbadie, on the operations for junction of the triangulation of Algeria to that of Spain, by M. Perrier. These have been quite successful, and the meridian of France is now extended to the Sahara. The electric light was used in signalling.—On the synthesis of diphenylpropane, and on a new mode of formation of dibenzyl, by M. Silva.—Reaction of the cyanamide with the chlorhydrate of dimethylamine, by M. Tatarinoff.—On the cleistogamic state of *Pavonia hastata*, Cav., by M. Heckel. Physiologists who, like Pontedera and M. Bonnier, represent the *rôle* of nectaries to be that of organs of nutrition of embryos, have to give account of the fact that in the same cleistogamous plant, the close flowers, without nectar, are as fertile as the perfect flowers, sometimes more so, and sometimes fertile to the exclusion of these others.—Upper sands of Pierrefitte, near Etampes, by M. Meunier. He calls attention to some new species of molluscs represented there.—On the mineral associations contained in certain trachytes of the ravine of Riveau-Grand, in Mont Doré, by M. Gounard.—M. Chasles presented the first part of a memoir on the history of geodesy in Italy from the most ancient times to the middle of the ninteenth century, by Prof. Riccardi.—M. Larrey presented an English work by Mr. Longmore, on wounds by fire-arms.

CONTENTS

THURSDAY, OCTOBER 23, 1879

THE INTRA-MERCURIAL PLANET QUESTION

IN No. 2253-54 of the *Astronomische Nachrichten*, Dr. C. H. F. Peters, the discoverer of so many minor planets, has "Some critical remarks on so-called intra-Mercurial planet observations," including the observations reported by Prof. Watson during the totality of the eclipse of July 29, 1878. Replies to these remarks have since appeared from Prof. Watson and also from Mr. Lewis Swift, of Rochester, New York, who, it will be remembered, also considered he had seen an object which could be no known star or planet. Prof. Peters enters upon other cases where intra-Mercurial bodies have been suspected, but we shall confine ourselves mainly here to his criticism of Prof. Watson's observations during the last eclipse. His object is to adduce evidence disproving Watson's conclusion that he had seen one, probably two unknown planets, and he grounds his argument chiefly upon the small size of the circles to which Watson trusted, and the fact that nearly on the parallel of his two objects a and b, and at an almost equal distance, a small one, in right ascension, were the stars θ and ζ Cancri. He states that the circles of wood with paper scales pasted on them, were only 5 and $4\frac{3}{4}$ inches respectively in diameter, and as Prof. Watson estimated the probable error of a position given by them at only five minutes, the space would measure on the circles only $\frac{1}{275}$ of an inch, and further he states that the wires which served as pointers "were so elastic as easily to give way several degrees under the touch by a pencil." So far, therefore, from accepting Watson's estimate of the precision of his readings, Prof. Peters thinks he does him no injustice in supposing that they were made "at the utmost to $\frac{1}{16}$ inch, corresponding to twenty minutes of arc upon his circles;" and in this case, the differences of a from θ Cancri, and of b from ζ Cancri, or + 2m. 55s. and + 3m. 23s. respectively, he believes may be explained by the errors in the markings or readings. It is also urged that the markings for the sun were made under circumstances less hurried than those for the suspected planets. Watson estimated the objects at the time of 4 and $4\frac{1}{2}$ magnitude, and, remarking that absolute magnitude must be quite uncertain under such conditions, Peters points out that the difference of brightness corresponds pretty nearly with that given by Argelander, Heis, and others between ζ and θ Cancri; and he adds, "it is, therefore, quite apparent to every unbiassed mind that Watson observed θ and ζ Cancri, nothing else." It should be added that Prof. Peters attempts to explain the ruddiness of the object near θ,—"If the sand ledge, under the lee of which the telescope was standing had nothing to do with it;" the observation, perhaps, teaches that the corona possesses the property of less absorbing the red rays, and may, therefore, be of some value. It seems also, in his view, that the corona gives a disk to the stars, or calms down the radiations to a kind of spurious disk, as a slight fog does; and as he does not admit that the power employed would show a real disk, we are to assume this was the case during Prof. Watson's observations. With regard to Mr. Swift's observations, it is represented that his successive publications offer so singular a gradation in the statements as to unfit them to be the subject of a scientific discussion.

As we have stated, Prof. Watson has replied to the criticisms which the Clinton astronomer has published to "make evident beyond cavil how erroneous the conclusion too rashly rushed at by the observers." He protests against mis-statement of the facts connected with his observations, remarking that it appears to him "the grossest of unfairness to attempt to discredit an observation made by an experienced observer by deliberately misrepresenting the circumstances of the observations." So far from the pointers of his circles bending under the touch by a pencil, they were made of unannealed brass wire one-eighth of an inch in thickness, not filed to a point, but to a *knife-edge*, placed vertical to the plane of the circle; they were quite rigid, and could not be disturbed in the least by the pencil when marking. The probable errors attributed to his readings Watson declares to be absurd, and says that any one interested may, by a few trials ascertain that by the method he adopted it is possible to measure without a greater probable error than 2′; the limit of 5′ which he gave was an outside one. Peters had urged that a practised observer would have compared the object a directly with θ Cancri, as the two would have been in the field together with the telescope employed, to which Prof. Watson replies, and with justice, that besides the want of time for such direct comparison, the method he was applying was different. If he had known that a new star would present itself near θ Cancri, he could have prepared himself for direct comparison; under the circumstances his plan of securing rapid indication of the position of any object that might be visible seems to have been as effective a one as could have been devised, and, as Dr. Draper termed it when it was explained to him the night before the eclipse, "a good dodge." Further, Watson observes that the assertion that his circles "were of wood, with paper scales pasted on to them, and wires serving as pointers," shows conclusively that Peters either did not yet understand his method, or that he was "purposely mis-stating the circumstances of his observations."

Finally, he makes what he terms these emphatic declarations:—"1. I observed, during the total eclipse of July 29, 1878, a new star between θ Cancri and the sun, and south of the sun, whose position and magnitude were as already published by me. 2. I observed another star, which I believe to be a new star, whose magnitude and position were as already published by me." Whether or not these objects were intra-Mercurial planets he does not positively assert, but he had the right to express the hones belief that they were. Watson adds that he "hopes ere long to give good reason for the faith that is in him," by which we understand him to imply that he has the intention to enter further upon the subject.

We will venture to say that the general feeling amongst astronomers when first reading Prof. Watson's announcement of his observations during the totality of the eclipse of 1878, of one, if not two, unknown objects, would be that a man of such known ability and experience as an observer, and so good a practical astronomer, as shown, amongst other proofs, by his able treatise on practical astronomy, would not risk his whole scientific reputation by putting forth such a statement to the world, unless he

was firmly convinced of its truth and felt able to substantiate it; otherwise the fact that there were two known stars, on the parallel or nearly so, and less than one degree west of the objects supposed to be new, would probably have been felt to be an almost fatal objection to the reality of the discovery. It must be remembered that Watson asserts he did see θ Cancri as well as the neighbouring object a; Peters objects—"not at the same time though"—an objection which Watson does not notice in his reply, but which will be easily removed by him; it might perhaps be rather gathered, that if the objects were not in the field together, he satisfied himself of their distinctness.

Throughout Prof. Peters's criticisms, not only as regards the American astronomer's observations during the eclipse, but other reported observations of unknown bodies in transit over the sun's disk, there is evinced a certain *animus*, which might have been as well avoided, and there is a flippancy in his reference to Leverrier's labours on the theory of Mercury, which he hopes "will be investigated anew by a hand very favourably known in this field of research, and we may expect then to have the intra-Mercurial spectre put to rest definitively." Most astronomical readers will feel more respect for the opinion of our great physical astronomer, Prof. J. C. Adams, who, on presenting the gold medal of the Royal Astronomical Society to Leverrier in 1876, thus expresses himself as to the existence of intra-Mercurial matter, as indicated by the French astronomer's researches—"The theory of the planet has been established with so much care, and the transits of the planet across the sun's disk furnish such accurate observations, as to leave no doubt of the reality of the phenomenon in question; and the only way of accounting for it appears to be to suppose, with M. Leverrier, the existence of several minute planets, or of a certain quantity of diffused matter circulating about the sun within the orbit of Mercury."

It has been mentioned that Mr. Swift has also addressed a communication to the *Astronomische Nachrichten*, in consequence of Peters's criticism of the observations made during the eclipse. Mr. Swift notified, soon after the occurrence of that phenomenon that he had seen two reddish objects with sensible disks about 3° distant from the sun; their mutual distance he first stated to be twelve minutes of arc, subsequently correcting this estimate to seven or eight minutes, as it is given in a letter which he addressed to NATURE, vol. xviii. p. 539, but in the same letter, referring the position of one object to that of the other, which he believed to be θ Cancri, by means of the place of the star given by the Astronomer-Royal in a communication to this journal, he assigned a position which, as we pointed out (vol. xviii. p. 569), would locate the supposed planet at a distance of thirty minutes from the star, instead of seven or eight minutes. He now writes that the difference of declination (? right ascension) shown by his own and Watson's observations, had been "a source of solicitude," as he could see no way to harmonise them "till NATURE pointed out the error of reducing the eight minutes of arc to time, saying it was but 32s. instead of 2m. This changed the whole complexion of the matter. The scales immediately fell from my eyes, and for the first time I was able to see my way clearly through the difficulty with which it had so long been enshrouded." We should have been glad if we could explain in what manner the sudden illumination consequent upon our remarks reconciles the distances in question, and so clear the way for accepting Mr. Swift's observation as confirmatory of that of Prof. Watson. He tells us that he has been an observer of the heavens for twenty-two years, and we know that he has been the first discoverer of several comets, and have no intention to depreciate his claim to credence on any astronomical question, but it has naturally happened that the different statements and the hesitation felt as to the distance of the objects he observed has detracted from the importance which would otherwise have attached to his experiences during the eclipse.

AUSTRALASIA

Australasia. Edited and Extended by A. R. Wallace. With Ethnological Appendix by A. H. Keane, M.A. (London: Stanford, 1879.)

THIS stout octavo volume is one of the series entitled "Stanford's Compendium of Geography and Travel," based on Hellwald's "Die Erde und ihre Völker." Mr. Wallace tells us, however, in the preface that he has been able to utilise comparatively little of the translation of Hellwald's work, so that it forms little more than one-tenth part of the present volume.

The term Australasia is taken in a very wide sense to include the entire East Indies and the Philippines, New Guinea and Australia, and all the islands of the Pacific, even to Easter Island. The region extends thus around much more than one-third the circumference of the globe.

The book commences with a short general account of the main geographical and biological features of the area and then treats of its various subdivisions separately. The author divides his Australasia into six principal regions, viz., Australia, Malaysia, Melanesia, Polynesia, Micronesia, and New Zealand. He commences with a very interesting summary of the principal physical features and climatic conditions of Australia.

Australia with Tasmania is only a little less in area than Europe. Yet its highest mountain, Mount Kosciusko, is only 7,308 feet in height. Its greatest river, the Murray, has a basin the area of which is about equal to that of the Dnieper. The hottest climate in the world probably occurs in the desert interior of Australia. Capt. Sturt hung a thermometer on a tree shaded both from sun and wind. It was graduated to 127° F., yet so great was the heat of the air that the mercury rose till it burst the tube, and the temperature must thus have been at least 128° F., apparently the highest ever recorded in any part of the world. For three months Capt. Sturt found the mean temperature to be over 101° F. in the shade. Nevertheless in the southern mountains and tablelands three feet of snow sometimes falls in a day; in 1876 a man was lost in the snow on the borders of New South Wales. Snowstorms have been known to last three weeks, the snow lying from 4 to 15 feet in depth and burying the cattle. Forty miles of the railway from Sydney to Bathurst have been seen covered continuously with snow. Australia is the land of drought and flood. The annual rainfall at Sydney has varied from 22 to 82 inches. Lake George, near Goulburn, was, in 1824, 20 miles long and 8 miles broad.

It gradually shrank till, in 1837, it became quite dry, and its bottom was converted into a grassy plain. In 1865 it was a lake again, 17 feet deep; two years later, only 2 feet deep; and in 1876 it was 20 feet in depth.

The account of the flora of Australia Mr. Wallace takes from Sir Joseph Hooker's exhaustive essay. In the description of the zoology he makes a curious slip in stating (p. 57) that the Banded Ant-eater (*Myrmecobius*) has a greater number of teeth (fifty-two) than any known quadruped. He quite forgets the big Armadillo (*Priodonta*), which has nearly twice as many, to say nothing of the crocodiles. It is also hardly correct to say that the Monotremes have no teeth.

After an interesting summary of the geological features of the country and of the mode of occurrence of gold, an account of the natives ensues. It contains interesting information, but seems hardly precise enough, those points in culture in which Australians differ from all other races being hardly brought out with sufficient distinctness. Such a statement as "that the life of the Australian native is one of abundance and privation, idleness and activity," might be made of all savages in the world. It is hardly accurate to describe a boomerang as "about three feet long," boomerangs being used of very various sizes, and many of the Western Australian and Queensland weapons being of about only a foot and a half in length. Again, why denote the spear thrown by means of the throwing-stick as "about ten feet long"? The spears thus used are of most various lengths, and some employed at Cape York are not more than five feet long at the most. Again, the throwing-stick is not always "a straight flat stick," but ranges through many forms, one being oval and shield-like.

Throughout the book the implements and weapons of natives are described in a slipshod and insufficient manner, as where the Papuans are stated to possess "Knives and axes, both formed of sharply chipped flints, resembling those of the stone age found in Europe." We believe that no flint implement has ever been found in New Guinea. The Papuans have knives of obsidian, and stone-headed axes and adzes, but the blades of these latter are not made of flint, but of jade or greenstone, or some similar material, and are not chipped to an edge, but invariably ground smooth all over. The only recent savages, apparently, who employ unground stone axe blades are the Australians, and very many of their blades are wholly or partially ground. Again, the canoes of the Admiralty Islanders are described as "formed of a hollowed tree with the sides raised by a plank and fitted with an outrigger." Such a description might apply to numberless other canoes occurring in Mr. Wallace's region of Australasia. The peculiar interest in the Admiralty Island canoe lies in its having two outriggers, or rather, an inclined balance platform opposite to the ordinary outrigger.

The real interest in the study of savage weapons and implements lies in the differences to be observed in the form and structure of the contrivances used by each race. The implements manufactured are often as characteristic of the race as is its language. They have certain general family resemblances in their form to those employed by nearly allied races and certain special peculiarities, some, like words from a neighbouring language, have been imported, and may or may not have undergone subsequent modification, others are absolutely peculiar and characteristic. When taken as a whole they are as important for the elucidation of the past history, and the determination of the affinities of the races of men as are language, or even to some extent physical characteristics. A description of the implements used by a race in order to be of real value and interest, should point out what particular implements are peculiar to the race, and in what their peculiarity consists, and what are common to the race and its immediate allies. A mere catalogue of implements, ornaments, and weapons given without detail or explanation is valueless.

The several colonies of Australia are treated of in detail in the present work. In the account of New South Wales Port Jackson is, as usual, vaunted as one of the safest, deepest, and finest in the world, but it should always be remembered that though it is very pretty and very deep inside, its entrance channel is not deep enough to admit a first-rate ironclad, and that men-of-war sometimes suffer from lack of shelter in Farm Cove, and drag their anchors.

By an unfortunate slip, under the description of Queensland, *palms* of the genera *Cycas*, Areca, &c., are spoken of, a mistake the more misleading to unbotanical readers because Cycads are not unlike palms in outward appearance.

In the account of the Malay Archipelago which follows in the description of the Sulu Islands and their notorious pirates, it should have been mentioned that the Sultan of the islands has at last submitted to the Spanish rule on receipt of a sum of money. An arrangement to that effect was made about a year ago, and an agreement signed at Manila.

Dr. Horsfield's interesting account of the Tenger Mountain, the great volcano of Java, is quoted at some length in the account of that island. The crater of the mountain is said to "exceed perhaps in size every other in the globe;" yet it is only four miles and a half in larger diameter and three and a half in smaller, whilst the great crater of Haleahala, in the Sandwich Islands, really the largest in the world, is twice as big, measuring over twenty miles in circumference. Curiously enough, no mention whatever is made in the book of this wonderful crater, nor of the island of Maui, in which it occurs, in the very meagre account of the Sandwich Islands, in the part of the work which treats of Polynesia.

The first portion of the work, which treats of Australia and the Malay Archipelago, is by far the best. The account of Polynesia generally which follows is most indifferent, as might be expected from the astonishing fact that no reference whatever is made to the two most important works on the subject, viz., Meinicke's "Inseln des Stillen Oceans," and Gerland's stout volume in Waitz's "Anthropologie." If good use had only been made of these works the result would have been far more complete and trustworthy; but a translation of Meinicke's work would have been better still.

The figure given as that of a native of Fiji is very unfortunate, since the face is represented as elaborately tattooed, whereas tattooing on the face is excessively rare in Fiji, and tattooing on men at all rarer still. It is not correct, however, to state that "in Fiji the women only are

tattooed" (p. 488). Good photographs of Fijians are so common now and so easily procured that it is a great pity one of these was not copied for the book.

With regard to cannibalism in Fiji the statement is made that perhaps nowhere in the world has human life been so recklessly destroyed or cannibalism been reduced to such a system as here, and the putting of twenty bodies into the ovens at one feast is described as most astonishing; yet the New Zealanders, who are necessarily also treated of in this book, were quite as systematic in their cannibalism and far more profuse, as many as 1,000 prisoners having been slaughtered and put in the ovens at one time by them after a successful battle.

In the general account of Polynesia the Polynesians are said to have no bows and arrows. This is a mistake; both Hawaiians and Tahitians had bows and arrows, as we know from the writings of Cook and Ellis, though they did not use these weapons for war purposes. Ellis's account of the sacred archery of Huahine, where the ancient archery ground was close to his residence, is most interesting and full of detail. Bows and arrows were also used in Tonga and Samoa. To say of Polynesians generally that "all the men are tattooed from the navel to the thigh" (p. 495) is strangely misleading, since it would appear from it that all Polynesians were alike in their customs of tattooing, whereas, as is well known, the greatest differences occurred in this matter, and the description quoted would apply almost solely to the Samoans and Tongans, though there was a slight difference even between these two races in the matter.

Still more misleading is the statement that the Polynesians "have none of the savage thirst for blood of the Fijians," and that "their ceremonies are polluted by no human sacrifices; cannibalism with them has never become a habit." To such an absurd conclusion regarding Polynesians is the author led by his having separated off the New Zealanders from the Polynesians into a separate chapter. He treats of the New Zealanders correctly later on as "Brown Polynesians," like those he is describing as above. But cannibalism was not confined to New Zealanders amongst the Polynesians, but widely spread amongst all, occurring in the Hervey Islands, Paumotu, Tahiti, the Sandwich Islands, the Marquesas, and elsewhere. Human sacrifices were also regular institutions in all the islands, for example, in Hawaii, Tahiti, and the Marquesas, and in the latter group men killed their wives and children, and their aged parents for eating. In the time of Cook cannibalism was very much on the decline in Samoa and the Sandwich Islands, and had ceased in Tahiti, but evidence of its former more common occurrence was preserved in popular legends, proverbs, and traditions, and in some curious ceremonial customs. In the Paumotu Islands it long remained a regular institution, and Ellis saw a captive child there given a piece of its own father's body to eat. But what can be expected from a work on Polynesia which is without a reference to Ellis's "Researches," and in which Tonga is treated of without a reference to Mariner, or even mention of his name?

In the account of Tahiti Mr. Wallace becomes quite poetical, but stumbles rather in his zoology in consequence; he writes:—"The wayfarer's ears are ravished by the music of various songsters arrayed in the brilliant plumage of the tropics." There is, indeed, one thrush-like bird (*Tatare longirostris*) in Tahiti which sings sweetly, especially in the higher mountain regions, but it is no more brilliantly coloured than are singing birds usually elsewhere, in fact as dull as most songsters in appearance. There are brightly-coloured birds amongst the meagre list of about twenty-six land-birds of the island, but these are fruit-pigeons, parrots, and king-fishers. Though the great denudation of the surface of Tahiti is referred to the extraordinary steep and narrow ridges thus formed, and which are such characteristic features of its surface are not mentioned. The following passage will be most amusing to any one who knows anything of Tahiti. "At present we must visit the interior in order to see in their original forms the seductive dances of the native women, gaily decked with flowers." In fact the interior of the island is mountainous throughout, and uninhabited. The natives know very little about it, and it is quite a feat for a European to make his way across it. The dances in question take place usually close to the sea-shore, when they do occur now, and a large bribe administered to one of the native washermen will generally set one on foot, these worthies ministering to the pleasures of tourists as well as washing their clothes.

In the account of Rapanui (Easter Island), the conclusion "that at present the island is the great mystery of the Pacific, and that the more we know of its antiquities, the less we are able to understand them," is unworthy of the present state of ethnological knowledge. Too much mystery is made about the stone images of Rapanui, and in his "Tropical Nature," p. 291, Mr. Wallace, following Mr. A. Mott, actually brings these images forward as one of the proofs of a former general advanced intellectual condition of mankind as opposed to the accepted scientific position that primitive man was savage.

Earlier in the book he similarly cites the big upright stones found by Brenchley in Tongatabu as proving the existence of a preceding more highly civilised race. It is misleading to term these Rapanui remains "prehistoric," as implying that they have any vast antiquity. There is no reason to doubt that the present islanders, who are by language of Raratongan origin and by tradition come from Rapa Island, are the direct descendants of those who set up the images and constructed the underground houses for their chiefs. The wooden tablets with hieroglyphic inscriptions, and wooden gods cannot be very old, and the same characters are inscribed on the backs of the stone images, as may be seen in the case of the one in the British Museum as are cut on the slabs. The stone crowns on the images' heads merely represent the feather head-dresses worn by the chiefs. Similar blocks were appended to the heads of some of the Sandwich Islands gods and to the stone gods of the Marquesas Islands. The stone images are in point of artistic execution miserably low, and their workmanship does not go to prove that any high development of culture existed here in former times, though the absence of artistic merit would hardly be allowed to prove the opposite condition as to general culture by such authorities at least as those who ately erected a row of stone heads very little more advanced in their resemblance to the human form in front of the Sheldonian Theatre at Oxford. The Rapanui stone images resemble the wooden ones of the island in features

in many points, and there is also a resemblance in form between these stone images and the smaller ones of other Polynesian islanders. Mr. Wallace makes all the mystery out of the fact that the present islanders know nothing of the images, but savages quickly forget. The very name of the image platform Moai, as Meinicke remarks, seems to be the same as that of the old Tahitian chief's burial places, "Marae," Hawaiian, "Morai."

The account of the Sandwich Islands is very short and contains several errors. Mauna Kea, the highest of the three volcanic mountains of the Island of Hawaii, is described as an active volcano instead of as extinct. Kilauea should hardly be described as the most remarkable "*burning mountain*" in the world. It is really a lateral crater only on the side of Mauna Loa, the terminal crater of which is far more remarkable when in eruption than that of Kilauea. It is rather stretching a point to speak of the crater of Kilauea as a *fathomless* oval abyss, for tourists from the hotel on its brink usually walk nearly all over its bottom on a floor of hard lava, and the descent to the bottom is no great one. The figure given in the text as representing *Kilauea volcano* apparently is taken from a sketch of one of the ponds of fluid lava usually present at one end of the bottom of the crater.

No account is given of the ethnological characteristics of the Hawaiians, and nothing of the importance of the Chinese settlers in the group, nor of that of the developing half-caste population. The establishment at Honolulu of the hostile Church of England Mission is spoken of with the warmest approbation, whereas most unprejudiced persons regard it as an unmixed evil that the natives who have been Congregationalists for nearly eighty years, should be interfered with by a different Protestant sect.

In the account of New Zealand (p. 564) the possibility is suggested of a former land connection having existed between the Kermadecs and New Zealand. Such a connection would explain well some of the peculiarities of the flora, especially of the ferns of the Kermadec Islands, but unfortunately a depth of 2,000 fathoms was found by the *Gazelle* to exist between the two places, and the connection cannot therefore have existed. It is surprising that Mr. Wallace speaks of the Kermadecs as interesting *only* because they form a stepping-stone to Tongatabu to assist in the migration of Polynesians: he forgets entirely the interest of their flora as described by Sir J. D. Hooker.

The work concludes with an essay by Mr. A. H. Keane, on the Philology and Ethnology of the Inter-Oceanic Races. A long and very useful catalogue is given of the inter-oceanic races and languages, and of their very numerous and puzzling native names, with good references appended. It is very voluminous, and we were astonished to light upon an omission in so complete a catalogue. It was that of the Lutaos, the native name for the Sulu pirate race.

On the whole, it is to be regretted that Mr. Wallace has not studied other German sources of information than Hellwald's work with care. The fact is it is too much to undertake to describe Polynesia together with the Malay Archipelago, Melanesia, and Micronesia, all in one volume, and the result has been that Polynesia has suffered in treatment. The most striking defect in the book, however, lies in the meagreness of the references, the catalogue of which, at the beginning of the book is very small and contains almost solely English books. There is no reference to Finsch's work on New Guinea ("Neu Guinea und seine Bewohner") nor to the Goddefroys' publications; and with the splendid bibliography of Meinicke's and Gerland's works before us, the neglect of the literary side of the subject is most irritating; but Mr. Wallace, as most working zoologists know to their cost, neglected also to supply adequate references in his work on the "Distribution of Animals," and thus reduced the value of the work by at least one-half. If any one wishes to obtain a concise scientific account of any of the Polynesian or Melanesian islands, and references which will when consulted put them in possession of all the information to be obtained, they should read Meinicke's book, and not "Australasia."

In conclusion, our readers may be reminded that very much yet remains to be done in the exploration of the Australasian region, and most interesting results may be expected when the snow-clad Charles Louis Mountains of New Guinea, possibly 18,000 feet in height, shall have been climbed by the naturalist, and such other hitherto unvisited regions as the island of Timor Laut and the great central mountain of Ceram Nusa Heli, said to be near 10,000 feet in height, from which Mr. Wallace, who has best right to judge, expects great things.

OUR BOOK SHELF

Geological Glossary for the Use of Students. By the late Thomas Oldham, LL.D., F.R.S. Edited by R. D. Oldham. Pp. 62. (London: E. Stanford, 1879.)

THIS is a posthumous work by the late lamented Superintendent of the Geological Survey of India. In a modest preface the author's son, who edits the work, explains that its object is to furnish a companion to the recognised geological text-books by including such terms only as are likely to be met with by beginners, and explaining them in the most concise and simple manner possible.

The definitions given in the book are always brief and to the point, but in a few cases in the attempt to be concise, the author has scarcely succeeded in making his explanations sufficiently clear for a student. We notice that the common mistake is made of confounding together the German words *Keuper* and *Kupfer*. The book is, however, very carefully prepared and edited, the arrangement and typography leave nothing to be desired, and we have no doubt that it will prove of the greatest service to the class of students for whom it is designed.

Ueber die Tektonik der Vulcane von Böhmen. Von Dr. Ed. Reyer. (Vienna: Alfred Hölder, 1879.)

IN this memoir Dr. Reyer shows that the Schlossberg of Teplitz is really a volcanic cone which has been produced by the successive and continued out-wellings of masses of phonolite lava from a volcanic centre. This he is able to prove by a study of the position of the great divisional planes which intersect the mass. The diagram of the internal structure of the mass of volcanic material, which he is thus enabled to construct, shows the most complete agreement with that of the plaster models which Dr. Reyer has described in an earlier paper on the subject. The author also adds some interesting information upon the old denuded volcano of Klein Preisen, and the whole paper forms a valuable and suggestive contribution to our knowledge of volcanoes, which is well worthy of attentive study. J. W. J.

An Essay on Spiritual Evolution considered in its Bearing upon Modern Spiritualism, Science, and Religion. By J. P. B. (Trübner and Co., 1879.)

THIS is an essay of 150 pages by a thoroughgoing "spiritualist," according to the most "modern" signification of the term. As such it is not a book very easy to review in the pages of a periodical devoted to the consideration of modern science. Whether or not spiritualism has any basis of truth, it is certain that a genuine belief, if not in spiritual agency, at least in the occurrence of certain weird and inexplicable phenomena, has of late years spread with extraordinary rapidity, and now includes among its avowed supporters some distinguished scientific men of the day. The estimate that a reader will form concerning the merits of the essay will depend chiefly on his attitude of mind concerning its subject. For "J. P. B." assumes the genuineness of so-called spiritual manifestations, his thesis being that granting a future state and the reality of spiritual communications, these communications invariably teach a doctrine which is in harmony with—or rather analogous to—the doctrine of organic evolution; they teach that gradual development is the law of spiritual life after death as it is the law of bodily life before death. We feel that our function as reviewers ends, when we say that in all his statements of and references to the facts of physical science the essayist is accurate. These statements and references appear, indeed, to us more numerous than the treatment of his subject requires; but if so they at all events serve to show, what perhaps they are intended to show, that "J. P. B." is an intelligent man, who, while prosecuting his spiritual studies—whether in the body or out of the body we do not know—still keeps his eyes open to what is going on in the lower world around him.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Sun-Spots in Earnest

AFTER three days of total cloud, but after months and months of general watching for sun-spots, and seeing either nothing at all, or only the smallest possible points visible in my household instrument, merely a little picture-forming model of an equatorial by the ancient Ramsden—I could hardly believe my eyes this (Saturday) morning on beholding, even in spite of driving clouds, haze, and smoke, three comparatively enormous sun-spots besides strings of smaller ones connecting them. The group was situated not in the sun's northern, as all the other little points had been, but in its southern, tropic; not just coming into view at the following limb after unknown periods of concealed growth on the other side of the solar orb, but only a day or two past the very middle meridian of its earthward side.

Hence these gigantic spots may have burst, exploded forth, only a day or two ago, and just when their locality was turned towards the earth; and it is indeed greatly to be hoped that some regular and accomplished solar observer in one of the astro-physical observatories may have been lucky enough to have positively seized and photographed this, for years past, most unequalled phenomenon both in its suddenness and immense extent. The energy too which must have presided at their birth, was borne continued witness to this day by rapid changes in the configuration of the spots; and certainly, take them all in all, the long quiescent period of the sun's internal heat-forces seems now to be fairly over, and the wondrous orb, on whose influences we all physically exist, is embarked on a new cycle of radiant activity. PIAZZI SMYTH

15, Royal Terrace, Edinburgh, October 18

Climatic Effects of the Present Eccentricity

I HAVE just read the Rev. O. Fisher's letter (vol. xx. p. 577) asking for an explanation of the reason why the January temperature at the equator, when the earth is in perihelion, is not much higher than in July when in aphelion. The temperature to which Mr. Fisher refers is the ordinary temperature as indicated by the shaded thermometer, which, of course, is simply the temperature of the air. I do not think it is difficult to explain why the *air* at the equator in January cannot be much hotter than in July.

If it can be shown from observation that the black bulb thermometer which indicates, not the temperature of the air, but the direct heat of the sun does not stand higher at the equator in January than in July there would certainly be a difficulty, if the temperature of space be as low as $-239°$ F. It would be desirable to know if such is actually the case. Perhaps some of your readers might be able to afford some information on this point, which seems to have been overlooked by meteorologists.

In a future letter I shall give what appears to me to be the reason why the air at the equator is not hotter in January than in July. JAMES CROLL

Greenwich Meteorological Observations

WITH reference to Mr. Ellis's letter in NATURE, vol. xx. p. 576, it may be enough to point out that, as Table 77 gives only the mean temperature of each day and month of the year for the whole period of the twenty years' observations, we must look elsewhere for the mean temperatures of the months of each successive year; and that this information is not furnished by Table 52, seeing that the means of that table have been prepared without correction for omitted days. Could Table 125 have been accepted as giving accurate mean temperatures this information would have been before us; but as matters stand a table showing the mean monthly and annual temperatures of Greenwich during each of these twenty years remains still to be constructed. An explanation as to how the daily mean values for those days on which no photographic value was available, were obtained in constructing Table 77, and a statement of the daily inequality of temperature of the underground apartment in which the photographic barometer is placed, would enable meteorologists to value even more exactly the highly important results of the Greenwich Meteorological Observations.

ALEXANDER BUCHAN

Rag-Bushes

CONSUL LAYARD has given a remarkable instance of this form of fetishi m, practised by the Cingalese, near Jaffna, as illustrating the paper read by Mr. Walhouse at the Anthropological Institute, April 8, 1879. When passing through the Betsileo forest country many years ago we came frequently on somewhat analogous monuments.

"Often on the summit of some of the steepest ascents we found huge piles of branches, twigs, bits of cloth, &c., the thank-offerings of passing travellers for having reached thus far on their journey and surmounted the hill" ("Madagascar and the Malagasy," p. 32, Lieut. Oliver, R.A.). According to Mr. George A. Shaw, of the London Missionary Society, in the last number of the *Antananarivo Annual*, "These heaps are called *tatào*, and have been added to at various times by people carrying firewood or dried grass, &c., to market. They throw on a piece 'for luck,' repeating a form of words, signifying, that if they are fortunate in getting a good price for their goods, when they return they will add another piece to help the *tatào* to grow large. Men driving cattle, or sheep, or pigs, throw on stones with the same speech, often spoken mentally only."

The Rev. R. Batchelor, S.P.G., who accompanied Bishop Kestell-Cornish to the Antankarana country also mentions that when, in trying to knock down the seeds, he threw pieces of wood and stone up at a fan palm, he was requested to desist by one of the villagers "as the tree was *Zànahàry, i.e.*, God, adding at the same time, that a man who had dared to cut the trunk with a knife had been killed the same day by Zànahàry's anger." But should I find an intelligent Malagasy battering one of my pet conifers to obtain the cones I should also remonstrate, and unless he was a good linguist he would assuredly believe that I considered my specimen-plants *sacred, i.e.*, from stones and sticks. A far better example is that recorded by the Rev. J. Richardson, Head Master of the London M.S. Normal School at Antananarivo, as occurring at Vólotaràỳ, in the Bara country,

en route to St. Augustine's Bay: "As we drew near to Vólotaráy River and town, I noticed a fetish tamarind tree that calls for a little notice. The tree itself is one of the largest in the neighbourhood, and is a notable object when viewed at a distance. The whole aspect of it strikes the stranger at once; its bell-shaped crown, and its branches reaching to the ground being particularly noticeable. I found on close examination, that its trunk divides into two a few feet from the ground; the diameter of its shade is 81 feet, and its branches torch the ground all round the circle. Through its branches there are other trees growing, seeking the sun through its dense foliage; some of these trees are quite a foot in circumference, and there are creepers clinging to them. So that the tree is a miniature forest in itself. The cool shade beneath its branches was most welcome. About a foot from the double trunk a trench encircling the tree has been cut in the sandy soil. This trench, or gutter, is about six inches deep, a foot broad, and is swept most scrupulously clean by some one, and the ridges on each side are patted down so that the sand may not fall into the gutter.

"On the raised earth between the gutter and the trunk of the tree are laid small baskets, mats, fan-palm leaves, locks of hair, &c., &c., and on the surrounding branches similar articles are hung, evidently placed there in making a vow, or as a thank-offering for some benefit, but what I could not tell. The tree is some hundred yards from the town, and when we arrived and inquired about it, no one knew (?) anything of there being such a tree. . . .

"The tamarind trees are apparently held in reverence by the Tanòsy as well as by the Bara, and at some little distance from Rabòdo's compound, at Kiliarivo, there is a very fine specimen of a fetish tree, to which they gave the name of Zànahàry. It is surrounded by a very high fence of prickly pear, and the narrow passage to it had been made impassable by cutting from the fence portions of the thorns and strewing them across the path."

Following is the translation by Mr. Jas. Sibree, jun., L.M.S., from an account by a Hova officer, who commanded an expedition against the Sàkalàvas in 1873:—"Before coming to this village we saw other things of a similar kind, for there is a certain tree they call 'Botóna,'[1] and in this tree there is some part considered as specially belonging to God. So they put on it a small mat about a hand-breadth in width, and they take long dry grass and twist it together, and hanging an ox-skull to the tree, they colour the tree with lines of charcoal and white clay and some yellow substance resembling turmeric, and then pray and render adoration before it. And many are the charms they place on the tree, fastening them to it, and every charm has a name peculiar to it. These are some of them: one is called 'Road-stopper,' another 'Raising up at a distance,' and another 'God's banner.' . . . In another direction which we took we saw some villages with a great many trees growing round them, and the largest tree which grew near the gate had a figure of a woman fixed to it, and ornamented with charms. We asked the meaning of this, and were told, This is the tree of adulterous desires, for here those pray who want women or are about to marry."

I may add that Mr. Richardson, mentioned above, with his wife and family, have lately landed in England, per steamer *Agra*, from Madagascar. It is greatly to be hoped that the reverend missionary will give a detailed account of his adventurous journey to the south-west coast. S. P. O.

[1] Botóna, or Bontóna is the Baobab, or monkey-bread tree (*Adansonia digitata*).

The Theory of Hailstorms

Would you kindly allow me the space in the columns of your valuable journal to make a few remarks on this subject? Before proceeding, I would like to mention three results of observations on hailstorms in general. It has been observed (1) that they move over the country in sharply-defined bands; (2) that these long bands have their origin or source in mountainous regions; and (3) that the air, previous to the occurrence of the storm is frequently hot and sultry, and that when it has passed, the wind feels sharp and cold.

Theorists admit that the generation of hail seems always to depend on some very sudden introduction of an extremely cold current of air into the bosom of a quiescent, nearly saturated mass. Now, bearing in mind the above-mentioned facts, does it not seem probable, or at least possible, that hailstorms may be caused by a current of wind which has been forced over snow-covered mountains, and thus rendered extremely cold, descending into the warm plains beneath, and forcing the hot and saturated air resting thereon, into the higher regions of the atmosphere, where the moisture would become congealed into a cloud of ice particles, the condition required for the beautiful theory of the formation of hailstones of Prof. Osborne Reynolds? This would account for the great frequency of hailstorms in Southern France, which country is subject to the influence of both the Alps and the Pyrenees. The above conditions, viz., snow-covered mountains and warm plains, could only occur in this country in winter and spring, and it is found that the greatest proportion of our hailstorms are experienced in these seasons.

I do not here enter into details. Should the theory be considered admissible, I hope on some future occasion to give the results of a full investigation of the subject, with my arguments in support of the foregoing opinion. J. A. B. Oliver

Springburn, near Glasgow, September 29

Underground Tides

Mention is made in Nature, vol. xx. p. 401, of a spring in the Dux coal mines, Bohemia, exhibiting ebb and flow similar to tides. May not this be due to a subterranean syphon, acting precisely as a Field's flushing tank would in a house drainage system Mention of such springs is made in Silliman's "Principles of Physics." We have in our neighbourhood not far from the Mammoth Cave a surface pool about 50 feet in diameter exhibiting this apparent tidal action. The pool is situated in the cavernous limestone country that forms such a large portion of our state, and is only a few hundred yards from Green River, whose peculiarly tinted waters it closely resembles. There is but little doubt that the river furnishes it with water until a level is reached, bringing one of the numerous underground conduits in the limestone into action, when the pool ebbs.

Louisville, Ky., U.S.A., October 9 Morris B. Belknap

The Uses of Tails

A very important function of the tail of the yak, cat, squirrel, and many other animals, to which I drew attention some years ago, has escaped the notice of Prof. Mivart. It is that the bushy tails of these animals serve a very important function in preserving their body-heat during their nightly and their wintry sleep. In cold weather animals with bushy tails will be found lying curled up with their tails laid carefully over their feet like a rug, and with their noses buried in the fur of the tail, which is thus used exactly in the same way and for the same purpose as we use respirators.

I have a Manx tailless cat, who cannot, of course, carry on this function, but he makes a very good substitute for it by using the back of one of my other cats. When he cannot be so accommodated, he sleeps with his hands crossed over his face, "just like a Christian," as my cook says. Lawson Tait

OUR ASTRONOMICAL COLUMN

Binary Stars.—Dr. Doberck, of Col. Cooper's Observatory, Markree Castle, Sligo, continues his interesting investigations on the orbits of the revolving double stars, and now gives a first approximation to the elements of O.Σ. 298, which, since the first measures by Mädler in 1843, has advanced upwards of 135°, the distance, meanwhile, diminishing from about $1\frac{1}{4}''$ to $0''\cdot3$; the passage of the periastre is fixed to 1881·76, and the period of revolution assigned is 68·8 years. It may soon be possible to infer approximately the elements of several other binaries as μ Herculis, O.Σ. 518, the duplicity of which was detected by Herschel in 1783, and which has special claims to the attention of the observer, from its evident physical connection with the rapidly-moving star 40 Eridani (one, by the way, that Mr. Gill intends to attack for parallax), and No. 298 of M. Otto Struve's catalogue. In a new orbit of Σ 3062, by Dr. Doberck, the period is 102·94 years; periastre 1835·5.

The Satellites of Mars.—Mr. Marth has published data for facilitating the calculation of the positions of *Deimos* and *Phobos* (*Ast. Nach.*, No. 2280), including for

the former satellite the partial effect of perturbation, and leaving the remainder of the process in as simple a form as practicable. He remarks that if the satellites cannot be followed up to December 15, there is little chance of their being seen in 1881, except, perhaps, under greatly improved atmospheric conditions, and we may then have to wait for further observations until the very favourable opposition of 1892; a similar opinion has been expressed by Prof. Newcomb; hence the greater necessity for reliable measures of the satellites during the present opposition. We have not yet heard of any observation of *Phobos* in this country, but Mr. Common continues measures of the position of *Deimos*, which is not far from that given by Hall's elements.

THE MINOR PLANET, PANDORA.—Dr. Axel-Möller, of Lund, has communicated to the Academy at Stockholm an exhaustive determination of the orbit of this small planet, which he appears to have taken under his special charge. It is founded upon the observations at the sixteen oppositions between 1858 and 1877, the perturbations of Mars, Jupiter, and Saturn being rigorously determined by Encke's method. The residual errors are smaller than in any like case we remember, except in Mr. Godward's investigation of the elements of Ceres in 1878, from a similar length of observation (fifteen oppositions) and refined calculation of the perturbations. Dr. Axel-Möller had presented an elaborate memoir on the absolute perturbations of *Pandora* to the Swedish Academy in 1877.

PALISA'S COMET.—Herr Zelbr, of Vienna, has published elements of this comet, which will be probably nearer the truth than any others that have appeared; they are founded on four days' observations between August 21 and September 12, and are as follow:—

Perihelion passage, 1879, October 4·60015 M.T. at Berlin.

	°	′	″	
Longitude of perihelion	202	27	15	Mean Equinox, 1879·0.
,, ascending node ...	87	7	30	
Inclination	77	6	12	
Log. perihelion distance	9·995932			

Motion—direct.

These elements give for Berlin midnight:—

	R.A. h. m. s.	Decl. ° ′
Oct. 23	15 36 56	+ 2 7·0
25	— 42 58	+ 0 24·4
27	— 48 50	− 1 15·2
29	15 54 32	2 51·8
31	16 0 6	4 25·3
Nov. 2	— 5 31	5 55·8
4	— 10 48	7 23·3
6	— 16 0	8 48·0
8	— 21 8	10 9·9
10	— 26 10	11 29·0
12	— 31 8	12 45·5
14	16 36 2	−13 59·4

On November 8 the intensity of light has the same value as on the day of discovery, August 21.

GEOGRAPHICAL NOTES

TWO members of the Greenland Scientific Expedition, viz., Lieut. Jenson and M. Kornerup, arrived back at Copenhagen on October 13 in the Greenland trading ship *Ceres*, which sailed from the colony of Egedesminde September 4. Lieut. R. Hammer left Egedesminde at the same time for the colony of Jacobshavn to take up his winter station there, in order to fulfil the special duties intrusted to him. M. Steenstrup takes up his winter station in the Umanak district, and it is intended that Steenstrup and Hammer shall meet next year, so that they may prosecute their researches together.

MÉNILIK, King of Shoa, has written a letter to the president of the Geographical Society of Paris in reference to the scientific mission which has been sent to Shoa by the Geographical Society of Rome and which has the protection of his government. But the King would like better to have to assist a French mission sent to him by the Geographical Society of Paris; consequently he desires the Society to fit out an expedition, promising them to employ all his power on their behalf. He complains bitterly against the Egyptian Government, which prevents Abyssinia from being placed in communication with European civilisation as it had been in former centuries. The letter is written in French and sent with an Abyssinian translation.

THE Grand Duke Nicholas of Russia has ordered M. Barante to translate into French his work "On the Canalisation of the Amu-Daria" and present it to the Paris Geographical Society. The work will be published *in extenso* in the Transactions of the Society.

A TELEGRAM received by the Russian Geographical Society communicates the following particulars as to the scientific expedition now exploring Tibet, under the leadership of Col. Prshevalski. On May 1 it was on the river Boolagan, having marched nearly 600 versts from Saizan, through Booluntokhoi, up the river Yrungo. The Colonel intended crossing the southern Altai Mountains by the shortest way to Barkool. All his companions were in good health, and success had attended all their efforts. Another telegram to the Russian General Staff, dated May 30, states that Col. Prshevalski had then accomplished a third part of the distance between Saizan and the Himalayas, reaching the town of Khani, whence he intended going to Shadsheoo and Paidan. Another Russian geographical expedition, it will be remembered, in three sections, is at present prosecuting researches east of the Caspian, though the same success does not seem to crown its labours. A letter reaching St. Petersburg by way of Orenburg says that the scientific party sent out to explore the Amu Darya, or Oxus, was attacked by about 100 mounted Turcomans, who were, however, repulsed. The whole course of the Amu Darya, as well as of its affluents, is described as having been found navigable.

M. REVAEL, who spent a long time with the Somalis on the western coast of the Gulf of Aden, has described to the Geographical Society of Paris the land and its inhabitants, who appear to be very anxious to trade with Europeans, and he presented an Arab firman signed by the Sultan inviting foreigners to visit his dominions. M. Revael is to return to Somali land with Prince Albert of Monaco.

IN the belief that not much is generally known in England on the subject, Mr. Consul Gollan devotes a considerable part of his last official report to a description of the geographical position, climate, population, industries, &c., of the two provinces of Santa Catharina and San Pedro do Rio Grande do Sul, in Southern Brazil. The former lies between 26° and 29° 30′ S. lat., and 48° 30′ and 52° W. long.; it contains an area of about 14,700 square miles, with a population of almost 160,000. The latter province, usually known as Rio Grande do Sul, lies between 25° 30′ and 32° 30′ S. lat., and 49° 40′ and 58° 20′ W. long.; it has an area of 118,758 miles, with a population of 430,000. The climate, more especially of the latter province, is described as excellent, a term which does not apply to the upper portions of the empire. Being some 700 miles outside of the tropics, these provinces have the advantage of a temperate climate, and are consequently the best adapted to immigration.

A LLOYD'S telegram dated Kobe, October 17, reports the *Vega*, Swedish exploring steamer, arrived at that port on the 14th inst.

SERIOUS preparations for the construction of a railway into the interior of Africa are now being made in France.

French engineers are investigating the territory from the starting-point of the future line to the Laghouat in the south. From that point as far as the line from Ain Sala au Khat military-technical expeditions are to prepare the way. Besides this the Oran Geographical Society and the Vice-Prefect of Tlemcen are to send caravans along the frontier of Marocco. MM. Soleillet and Duveyrier will travel on their own account for the same object.

A MEETING took place at Dortmund on the 4th inst., which had for its object the discussion of a project for connecting the Rhine and the Weser by means of a canal. The Government presidents of Westphalia, of the Rhineland, and of Hanover were present. The canal will be constructed *viâ* Ruhrort and Heinrichenburg, but it is undecided as yet whether from the latter place it will proceed to Emden or to Minden. Special committees were formed for the purpose of further investigating the latter question.

MESSRS. SCHMIDT AND GÜNTHER, of Leipzig, will shortly publish an elaborate work on India by Emil Schlagintweit. The work will appear in thirty-five parts, and will be profusely illustrated by eminent artists.

A PARLIAMENTARY caravan comprising about twenty members of the French Senate and Chamber of Deputies is travelling all over Algeria in order that the legislators may become acquainted with the peculiarities of the land and inhabitants. The tour will be terminated at the end of the month.

THE PLANETS OF THE SEASON

SELDOM could the aspect of the nocturnal sky be more attractive to the student of planetary phenomena; seldom has his inquiring gaze been repelled more pertinaciously by

"Vapours and clouds and storms,"

than during the past anomalous season; and our English climate has more than maintained its accustomed forbidding character, just when a few nights of transparency would have been especially welcome. Better things, however, may still be in store; and in that hope the following remarks on the distinctive features of the present ornaments of our midnight sky may be admissible as possibly of some suggestive value to comparatively inexperienced observers.

We have for some time past had a simultaneous presentation, under the favourable circumstances of proximity to the earth and a greatly improved altitude as compared with recent oppositions, of three peculiarly remarkable objects, the most magnificent, the most ornate, and—so to speak, the most earth-like member of the planetary family. Each holds his own pre-eminence on his own ground; each bespeaks especial study from his own individual character; and it is probable that some acquaintance with foregone results may economise time and labour by enabling us to leave on one side what is already, in comparison, sufficiently known.

The examination of Jupiter is not at present quite as satisfactory as it would be with as much north as he has south declination; it is always, however, greatly facilitated by the broad expanse of his noble disk, and a brilliancy so great as to have occasioned a suspicion of unborrowed light, emanating from internal incandescence. While, however, the shadows of the satellites upon his surface are so intensely black, and the satellites themselves so utterly invisible in eclipse, it is evident that any accession of luminosity from such a cause, even if it exists, must be quite insensible in the general effect, which can only be ascribed to an extraordinary reflective power in the whiter portions of the globe. A diminution of brightness towards the limb, which might be anticipated on optical grounds, and is frequently demonstrated by the reversal of the aspect of a passing satellite from light to dark, or the contrary, is nevertheless not distinguishable by the eye, nor even when a portion of the light has been intercepted by darkening glasses; it is, however, apparent if the screen is deep enough in tint to extinguish the satellites. This was scarcely to be expected. It might have been supposed that a central region so bright as to exhibit a white disk in front of it as dark, even to blackness, by contrast, could not escape being itself strongly contrasted with a border so much fainter that the same disk appears luminous on it as a background. Yet the difference is not obvious; and no other cause can be assigned excepting the imperceptible gradation. The idea of absorption in the upper region of an extensive atmosphere, not otherwise manifesting its existence, has indeed been entertained; but it seems unnecessary. The observed decrease of brilliancy is only what would result from obliquity of incidence in the solar rays, and it probably exists in no greater proportion than is due to that cause. The atmospheric hypothesis might indeed have been directly tested, by comparing the brightness of the satellites when near the limb in the superior and inferior portions of their orbits, had their light been sufficiently equable; but its variations are too evident and at the same time too irregular to render such comparisons satisfactory. A long course of observation might indeed eliminate these discrepancies, but it is questionable whether the result would repay the labour. Nevertheless the fact referred to, of the incompetence of, at least, ordinary vision to detect the diminution of light towards the limb is worth attention, as leading to inferences rather unfavourable to the sensitiveness of the eye in some of the processes of photometry. At a considerable distance from opposition, when the terminator encroaches slightly on the elliptical form of the limb, the defalcation of light on that side may be readily detected.

As to the real nature of that magnificent globe we are compelled to admit an embarrassing amount of ignorance. We see indeed that it is encompassed by an envelope, subject to occasional disturbances of a nature which on our earth would necessarily infer the extensive prevalence of vapour, sometimes in tranquil suspension, at others either agitated by rapid currents, or subject to equally speedy processes of precipitation and solution. Beyond this we can hardly be said to know anything. Jupiter is in no respect an enlarged resemblance of the earth. With so little similarity in point of density and gravitation—with so slight a diversity of seasons—with such rapid interchange of day and night—could we be transported there, we might probably find ourselves as among the imagery of an incomprehensible dream. Vapour we might recognise—and vapour occasionally in a state of rapid change; but possibly not the vapour of water; and whether exhibiting itself in the luminous or shady spaces could hardly be decided by a mere comparison with terrestrial clouds. These would no doubt be to a distant eye brighter than the surface beneath them, but among so much that is dissimilar a single point of analogy would hardly bear much weight; it is, however, the more probable alternative that the dark bands are the transparent part of the atmospheric envelope, from the fact that these become less distinct towards the limbs. The obliteration is not indeed always apparent, and is often absolutely imperceptible in a sharply defining instrument; but it has been frequently referred to, and if these ideas are correct, it may probably be found that in proportion to the darkness of the belts will be the nearness of their approach to the edge of the disk. The disappearance of dark spots near the limb would be accounted for by the rules of foreshortening in perspective.

The tendency to an equatorial arrangement in these streaks is one of the most familiar features of the planet; and almost self-evidently connects itself with the astonish-

ing velocity of rotation; yet there is a "missing link" which cannot readily be supplied. Friction against a surrounding medium, *combing out*, as it has been expressed, the vapours in a longitudinal direction, can hardly be admitted on mechanical grounds; and there is difficulty in conceiving the arrangement of the restoration of equilibrium in currents which set in one direction over the whole visible globe, if they originate by ascending from warmer depths, and lagging behind in a higher and more swiftly rotating region. We may remark, in passing, that only a trifling elevation of the luminous above the grey region, with a corresponding slight difference in velocity of rotation, is compatible with the undeviating contour of the limb as far as our telescopes may show it; though, of course, given an unlimited duration of time, the slightest preponderance would be ultimately adequate to such an effect. Possibly the best explanation may lie in some modification of electrical or magnetic polarity. At any rate the influence, though predominant, is not irresistible, since it neither precludes the formation of belts of a certain amount of obliquity, nor mixes up in confusion, though it seems to elongate, those very remarkable insulated luminous masses which occasionally encompass the gigantic equator in a comparatively equable series with a string of great oval beads, sometimes so curiously and uniformly shaded as to convey an almost irresistible impression of high relief. This strange phenomenon, not confined, as Dawes has found, solely to the equator, seems wholly beyond our conjectures. Nor can we satisfactorily explain those large spots, much darker than the belts, as though the atmosphere were there more perfectly transparent, which have occasionally shown such remarkable persistency as to indicate some relation to definite regions on the surface beneath them; at other times have disappeared with startling rapidity; and usually have been so far from absolute immobility that every attempt to determine the rotation by their means has ended in mere approximation. The occasional detection, too, of many minute white specks, like passing satellites, in various parts of the disk, has added nothing to our knowledge beyond the fact of their presence. The abnormal flattenings of the limb which have sometimes been noticed on the approach of a satellite, or even without it, seem to be of an illusory nature. And yet nothing should pass without attention.

Few things in this wonderful planet are more striking than the singular and beautiful colouring which occasionally adorns the disk. For a considerable season nothing beyond some feeble tinge may be made out, especially in the equatorial zone; then again we shall find purple, brown, greenish yellow, orange, and rosy tints marking out the surface with delicate but unmistakable variety. The darker the grey of the belts, the more apt it is to show a slaty purple hue; the polar regions sometimes, as at present, differ slightly in tint, so that temperature does not seem to be connected with it. The rosy spot of the present season south of the equatorial zone has naturally attracted much attention, and will of course be carefully watched. But as yet the origin of such varieties of colour sets conjecture at defiance. To depict these many changes both of form and hue will always be an interesting occupation, though it is never likely to have any more definite result than to deepen our sense of the wonders of creation, and our reverence for its First Great Cause.

One caution may be permitted here. It would be very desirable for those who attempt to delineate this magnificent planet that they should make themselves familiar with the perspective of a globe. The telescopic image has so precisely the aspect of a flat disk that it requires some mental effort to realise the fact that we are gazing on a great ball; and unless this is carefully borne in mind our drawings will and must be unsatisfactory. Especially it is perhaps seldom imagined how very little we know of the Polar regions, from an obliqueness of presentation amounting to virtual and unbroken concealment. From the analogy of Saturn we may infer that the poles of Jupiter present no remarkable feature; but it must ever remain a mere conjecture to all future generations.

It scarcely needs to be mentioned that no circular representation of the disk can ever give a resemblance tolerable to an experienced eye. An elliptical outline, apparent even with a power of 30 or 40, is too striking a characteristic not to affect materially the faithfulness of the picture.

Something remains to be said as to the beautiful retinue which attends on this leader of the planetary system and whose perpetual change of configuration is ever a source of fresh interest. In some respects they are subjects only for the finest telescopes, in others a very slight optical power can deal with them. The true dimensions of those minute disks are, perhaps, as fairly known as can be expected from measures of such difficulty; but the subject of their numerous changes of brilliancy, though frequently treated, cannot be said to be fairly exhausted. That such changes exist, and to an extent easily recognised in very moderate telescopes, is undeniable; and were they constant for the same orbital positions, they would find ready explanation in the very natural supposition that they rotate like our own satellite, each on his own axis, in the same time that they complete their monthly period. But this idea, though it approved itself to Herschel I. and Schröter, is found inconsistent with observation, which shows the changes to be too irregular in their returns; and we can only infer, what, indeed, has been actually shown by good instruments, both in front of and outside of the face of the primary, the variable darkening of portions of their disks, a result which, interpret it how we may, by atmospheric change, or unsymmetric rotation, or a combination of both (and no other supposition seems to occur), removes those little bodies still further from our analogies. There is no more resemblance between these satellites and our moon than there is between the primaries on which they respectively attend.

We must postpone our remarks on Saturn and Mars to a future opportunity.

T. W. WEBB

NORDENSKJÖLD'S ARCTIC VOYAGES[1]

IT is fifteen months, our readers will remember, since Prof. Nordenskjöld left Hammerfest in the *Vega* to prove that, if taken at the proper time, the North-East Passage is perfectly practicable. And the result has proved that he was right to within a day or two. Nearly a year ago he had practically accomplished the passage, and was only overtaken by the ice just as he was about to emerge into the Pacific. We know already that during their year's enforced imprisonment in the ice to the east of Serdze Kamen, Prof. Nordenskjöld and his accomplished and well-selected staff have made the best possible use of their time. We have already, on several occasions, briefly referred to some of the valuable results obtained in various departments of science, and the full narrative of the expedition will be looked for with impatience. We hope that it will be given to the world with the least possible delay after the leader's return to his home in Stockholm. Meantime we are concerned, not with this culmination of a long series of expeditions in the Arctic waters to the north of the Old Continent, but with the exploring work of its leader during the previous twenty years. Mr. Leslie has done good service in wading through the voluminous literature of Nordenskjöld's various expeditions, and culling from it the material wherewith to compile a

[1] "The Arctic Voyages of Adolf Erik Nordenskjöld, 1858–1879." With Illustrations and Maps. (London: Macmillan and Co., 1879.)

volume of genuine interest and of much scientific value, well provided with maps, and rendered attractive by numerous illustrations.

Mr. Leslie gives a preliminary account of the life of his hero, mostly in the latter's own words, and this is perhaps the most interesting part of the volume. Many of our readers do not need to be told that Prof. Nordenskjöld is a remarkable man, altogether apart from the long series of explorations in which he has done so much for a scientific knowledge of the Arctic regions. Nordenskjöld is a native of Finland, having been born in 1832, the descendant of an old family of good position. His father was chief of the Mining Department of Finland, and a well-known naturalist. Other members of this family were eminent in various departments of literature and science, and the grandfather, Col. Nordenskjöld, built a peculiar residence at Furgord, where stores of natural history have been collected. Here young Nordenskjöld was brought up, and while yet a boy was an industrious collector of minerals and insects, and was permitted to accompany his father on his tours, acquiring thus early the keen eye of the mineralogist. After attending the Gymnasium of Bergo for some time—

"Nordenskjöld entered the University of Helsingfors in 1849, devoting himself chiefly to the study of chemistry, natural history, mathematics, physics, and above all, of mineralogy and geology. 'Already before I became a student,' he writes, 'I had been allowed to accompany my father in mineralogical excursions, and had acquired from him skill in recognising and collecting minerals and in the use of the blowpipe, which he, being a pupil of Gahn and Berzelius, handled with a masterly skill unknown to most of the chemists of the present day. I now undertook the charge of the rich mineral collection at Frugord, and besides, during the vacations, made excursions to Pitkeranta, Tammela, Pargas, and others of Finland's interesting mineral localities. By practice I thus acquired a keen and certain eye for recognising minerals, which has been of great service to me in the path of life I afterwards followed.'

"After passing his candidate examination in 1853, Nordenskjöld accompanied his father on a mineralogical tour to Ural, devoting most of his attention to Demidoff's iron and copper mines at Tajilsk. Here he planned an extensive journey through Siberia, but the breaking out of the Crimean war put a stop to it.

"'After my return,' says Nordenskjöld, 'I continued to prosecute my chemical and mineralogical studies with zeal, and wrote as my dissertation for the degree of Licentiate a paper "On the Crystalline Forms of Graphite and Chondrodite," which was discussed under the presidency of Prof. Arppe on February 28, 1855. The following summer I was employed on a work of somewhat greater extent—"A Description of the Minerals found in Finland," which was published the same autumn. Various short papers in mineralogy and molecular chemistry were printed in "Acta Societatis scientiarum Fenniæ;" I also published, along with Dr. E. Nylander, "The Mollusca of Finland" (Helsingfors, 1856), as an answer to a prize question proposed by one of the faculty. In the interval I had been appointed Curator of the Mathematico-physical Faculty, and had obtained a post at the Mining Office as mining engineer extraordinary, with inconsiderable pay, and an express understanding that no service would be required from me in return. A salary was also attached to my curatorship.'"

Nordenskjöld did not, however, long enjoy these, his first paid appointments. Finland has never taken kindly to her severance from Sweden and her attachment as a province to Russia. Nordenskjöld naturally had a great love for Sweden, and on one or two occasions gave expression to his feelings in speeches at social gatherings. These expressions were certainly not significant of anything like disloyalty to Russia, but the shortsighted governor of the time magnified them into something like high treason. The result was that Nordenskjöld left Finland in 1857 and took up his residence in Stockholm; since then he has been to all intents and purposes a subject of the Swedish Government, and has risen in his adopted country to high honours. Shortly after his arrival he was appointed assistant to the celebrated mineralogist, Mosander, and in December, 1858, on the death of the latter, succeeded him as Professor and Intendant of the Mineralogical Department at the Riks-Museum of Copenhagen. Before this he had travelled and studied in various parts of Europe, especially in Berlin, had visited the Ural Mountains, and explored part of Finland. Since then he has more thoroughly explored Finland and visited many parts of the Scandinavian Peninsula, as a mineralogist. We need not remind our readers of the great amount of work done by Nordenskjöld, during the past twenty years in mineralogical investigation; his researches in this department have entitled him to take a high rank in his own department.

As a scientific explorer, Nordenskjöld is mainly known in connection with the work he has done in the five expeditions to Spitzbergen, of which he has been a member. These expeditions, it should be remembered, were not undertaken for the mere purpose of creating a sensation by the foolhardy feat of attempting to reach the pole at all hazards. Geographical discovery certainly formed a part of the programme of all the expeditions in which Nordenskjöld has been engaged, and on these occasions it was attempted to push as far north as was consistent with safety. In the expedition of 1868, for example, the *Sofia* succeeded in sailing to 81° 42′ N. in 17° 30′ E. long., 12′ beyond Scoresby's farthest; and in the spring of 1873 an attempt was made in man-drawn sledges (thirty-nine of the forty reindeer had bolted, and were never seen again) to push beyond the Seven Islands, but the condition of the ice was such that Nordenskjöld prudently abstained from risking his men's lives. The vessels in which the various expeditions have sailed have been of very small tonnage, in one case only $26\frac{1}{4}$, but this Nordenskjöld considered an advantage in pushing through the drift-ice. The expenses of the expedition have always been moderate, partly defrayed by Government, but mostly by private subscription; as our readers know, one of the most liberal supporters of Nordenskjöld's exploring undertakings has been Mr. Oscar Dickson, the wealthy Gothenburg merchant, to whom Mr. Leslie's volume is appropriately dedicated. The results obtained in these modest and inexpensive expeditions contrast strongly with those of the expensive and elaborately equipped expedition in the *Alert* and *Discovery*. On all these expeditions Nordenskjöld has been accompanied by a competent scientific staff, and the results obtained, both in the natural history and the physics of the Arctic region, have been of the first importance. By means of these and other researches the Riks-Museum of Stockholm has now, probably, the richest collection in mineralogy in the world.

On the first two expeditions to Spitzbergen, in which Nordenskjöld was engaged, 1858 and 1861, he acted as geologist under the leader Otto Torrell, the head of the Swedish Geological Survey. On the former of these several parts of the west coast were visited and explored. At Bell Sound, on the south-west of the main island "dredging was undertaken with abundant success, birds and mammalia were shot and prepared, a tertiary formation containing fossil plants discovered, and botanical collections made, particularly of mosses and lichens. "On July 6 they left this anchorage to sail northwards, but calms and head-winds compelled them to seek the north harbour in the same fjord. There Nordenskjöld discovered thick vertical strata of limestone and siliceous slates rich in fossils of the genera Productus and Spirifer, and which therefore appeared to belong to the carboni-

ferous formation, and found these strata overlain by other nearly horizontal beds belonging to the same tertiary formations with impressions of leaves as he had observed at Middle Hook."

The expedition of 1861 consisted of two tiny vessels. They managed to sail right round the west and north coast to the entrance of Hinlopen Strait, which divides the main island from North-east Land, anchoring in Treurenberg Bay, the starting-point of Parry's famous sledge expedition of 1827.

"The Swedes paid a visit to Hecla Cove, Parry's harbour, protected from the north by Cape Crozier with its hill of quartzite. It was on this point that Parry and his lieutenant, Crozier, carried on their magnetic and astronomical observations, and on this height they erected a flagstaff with a copper plate bearing an inscription to preserve the memory of their visit. Here was found a flagstaff, which, however, was only the highest portion of Parry's flagstaff, and the copper plate was cut away so that only a few small pieces remained under the heads of the nails with which it had been fastened. Hecla Mount, about 1,720 feet high, was ascended, and from its top an extensive view was obtained of North-east Land, which along the coast is very flat with rounded hills of inconsiderable height, and in the interior is covered with a continuous snow-plain of about the same or somewhat greater height above the sea than the top of Hecla Mount, and to the south of Niew Vriesland, the interior of which is also occupied by a similar unbroken snow-plateau. In the neighbourhood large masses of hyperite were found; and to the iron which the eruptive rock contains the Swedes attributed certain irregularities which appeared in the magnetic observations. Interesting as was the discovery of this rock on the other side of the bay to the geologists, it was not so to the physicists, who found that all their magnetic observations were affected by its presence."

Cape Chelyuskin, the Northernmost Point of the Old World.

During the weeks that elapsed from the imprisonment of the vessels in Treurenberg Bay till their release, the zoologists carried on dredgings, the other members of the expedition were employed in copying charts, with a view to future excursions, and in calculating observations; on board the *Æolus* meteorological observations were taken hourly; measurements were also made of the tides.

"At length the ice broke up, and on July 2 the ships got out to sea accompanied by the *Jaen Mayen*, a fishing vessel that had been imprisoned along with them.

"June is the spring month of Spitzbergen. The sun rose higher and higher above the horizon, and his rays were by no means powerless. The snow first became soft and water-drenched, and disappeared in spots from the ground. On June 11 *Cochlearia fenestrata*, and the polar willows began to open their buds; on June 22 the first expanded flowers of *Saxifraga oppositifolia* were gathered, a sign that the midsummer sun had at length won a victory over the northern winter, and on the 26th there were in flower *Draba alpina*, *Cochlearia*, *Cardamine bellidifolia*, and *Saxifraga cernua*, and here and there *Oxyria*, and the willow, and in the beginning of July *Cerastium alpinum*. Small *Poduri* hopped about in a lively way among the snow. By June 7 there were seen on Hecla Mount, more than 1,500 feet above the sea, a number of gnats, and on the 21st there were captured near Æolus's cross *Diptera*, which, however, were unable to raise their wings to a higher flight than a foot or two from the ground. Small spiders and a kind of worm, like our dew-worm, living in the already thawed ground, were found here and there."

After the ice broke up Torell and Nordenskjöld undertook a boat journey down Hinlopen Strait, during which a variety of important data were obtained and collections made. At several places they found immense glaciers,

one about seven miles long, and standing out into the sea with its perpendicular walls. South of Wahlenberg's Bay a bed of Permian fossils in great abundance was met with; these were the first fossils found in North Spitzbergen. After collecting a large quantity of fossils at Angelin's Mount, on the south-west of North-East Land, the party rowed along the shore to another mountain, 2,000 feet high, which strongly resembled it. This they named Lovén's Mount. Its upper part consists of hyperite, and with its flat, steep, and black sides strongly resembles a roof. Underlying the hyperite are horizontal lime- and sand-stone strata with nearly perpendicular faces towards the sound giving the whole mountain the appearance of a regular colossal building. Another rich collection of fossils was made here. The party then proceeded down the strait, but after two hours' rowing were met by fast ice which obliged them to turn. They then rowed along the west side of the sound, taking an hour to pass a broad glacier. After it they came to another which lay like a stratum of rock on a perpendicular cliff of hyperite, and accordingly tumbled with its ice over the rocks into the sea. The hyperite was found to be beautifully polished and marked, and here, as at several other places, were found many signs that the ice in former times had occupied a larger area on Spitzbergen. Between Dym Point and Cape Fanshawe the Swedes passed the greatest auk-fell they had hitherto seen. Here also was found, rising from the sea to a height of 1,000 feet, a perpendicular wall of hyperite, everywhere split vertically into basalt-like, upright, four- or eight-sided columns, standing free or only connected with the main rock by a small corner, and sometimes crowned capital-wise by a stratum of greyish-white limestone. After passing Cape Fanshawe the party next entered Lomme Bay, on the west side of which they found the largest glacier they had yet seen on Spitzbergen. It is about ten miles wide, and projects into the sound with a curved front. The stratification of the ice is horizontal. At Shoal Point, at the entrance to Hinlopen Strait, the beach was everywhere covered with an enormous mass of drift-wood among which are found pieces of pumice-stone, birch-bark, cork, poles, and floats from the Lofodden fisheries, with other things which had been carried hither by currents from the south. The drift-wood formed a broad line along the beach. Farther up was another line, where the water now scarcely comes even during spring tides, probably elevated by a raising of the land. In this line the drift-wood was far older and undergoing decomposition. While Torell was examining all this, he found among other things a well-preserved bean of the West Indian plant *Entada gigalobium*. This bean, which is upwards of an inch and a half across, floats with the Gulf Stream through the Atlantic, is found not unfrequently on the coast of Norway, and being also found on North Spitzbergen, affords the most convincing evidence that the Gulf Stream reaches this high latitude.

Bean of *Entada gigalobium* (natural size).

After the return from Hinlopen Strait, Torell and Nordenskjöld explored a part of the north coast of North East Land. Near Waygatz Islands, on the south of


In the Interior of King's Bay.

Hinlopen Strait, where one of the vessels lay for some time, the divergence between the marine fauna of East and West Spitzbergen was very striking. Here were found animals belonging exclusively to the fauna of Greenland, seen exceedingly seldom or never on the west coast. As an example of the flora to be found in Spitzbergen and of the thoroughness with which the expedition did its work, we quote the following passage from Mr. Leslie's volume:—

"After various excursions had been made the *Magdalena* sailed from the Norways on the 25th, and after passing Kobbe Bay and South Gat, the sound between Danes' Island and the mainland, anchored in Magdalena Bay. Here, at a height of 2,300 feet above the sea, the following plants were found growing, *Cochlearia fenestrata*, *Cerastium alpinum*, *Luzula hyperborea*, and several saxifrages; lower down, small soft tufts of the Arctic willow, *Alsine biflora*, and several grasses. Out of the gravel there rose nearly a foot high here and there the uncommon *Saxifraga hieracifolia* and *Pedicularis hirsuta* with its reddish head, alternating with yellow *Ranunculi* and bright red patches of the graceful *Silene acaulis*, of which, however, a flower here and there had begun to pale under the powerful rays of the sun, which had already caused several *Drabæ* and the here uncommon *Arabis alpina* to go to seed. High up on the fell grew the beautiful *Erigeron uniflorus*. By the side of the small streams that flowed from the top to the bottom of the mountain were mosses, *Saxifraga rivularis*, *Stellaria eduardsi*, and two species of *Poa*. It is remarkable that the vegetation diminishes quite inconsiderably with the height above the sea, so that almost all the plants that grow near the beach thrive as well at a height of 2,000 feet. The continual sunlight and the insignificant difference in temperature are undoubtedly the causes of this.

"The large granite blocks and broken stones, of which is formed the peculiar beach by which the fells are here almost always separated from the sea, are quite concealed by the most luxuriant moss and lichen vegetation. The grey covering, often six inches thick, is for the most part composed of lichens: *Sphærophoron fragile* and *Cladonia gracilis*, *Stereocaulon paschale*, *Cetraria islandica*—Iceland moss—*Bryopogon jubatum*, *Alectoria thulensis*, *Umbilicaria arctica*, *Solorina crocea* and many others; and among mosses of *Racomitrium lanuginosum*, with stalks nine inches long, *Encalypta rhaptocarpa*, *Gymnomitria* and *Bryæ*, *Polytrichum alpinum* and *Dicranum fuscescens*, &c. While the sloop lay in Magdalena Bay Cape Mitre was visited, a promontory which Scoresby ascended one of the few times he landed on Spitzbergen. When he had reached the summit, he was obliged to sit astride the ridge in order to keep his place. On July 31 the *Magdalena* again put to sea, and the same day anchored in Cross Bay. In this neighbourhood the first known fern on Spitzbergen was found—*Cystopteris fragilis*."

Dredging under the Ice in Winter.

In the neighbourhood of King's Bay, was found a seam of coal, together with impressions of leaves and other parts of plants, showing that there was a period in the development of the globe when spreading forests, composed, it would appear, chiefly of broad-leaved trees, resembling maples, everywhere covered the valleys and mountain-slopes, where now, if they be not entirely filled with thick beds of ice, the Arctic willow, creeping inch high along the ground, is the only representative of plants of the nature of trees.

Thus sailing from one point to another, making boat and land excursions, dredging and collecting plants, animals, fossils, and minerals, and studying ice and other physical conditions, the members of the expedition carried on their work, returning only when the ice threatened to lock them in for the winter. This is a fair example of the methods and results of the various expeditions in which Nordenskjöld has been engaged.

In the third expedition to Spitzbergen, in which Nordenskjöld was engaged, that of 1864, he himself was leader. The vessel was an old but strongly-built gunboat, the *Axel Thordsen*, of 26½ tons, part of the object of the expedition being to complete the preliminary survey to ascertain the possibility of measuring an arc of the meridian. On this occasion the expedition succeeded in landing on Bear Island, but on a subsequent expedition it was explored for five days. On the visit of 1864 Nordenskjöld inserted a water-mark at the Burgomaster Port, to register the rise of the land, which is going on in Spitzbergen as in other Arctic lands. After attempting

Stor Fjord, the expedition made for Ice Fjord, which, at its east end, sends off three branches. A careful examination was made of several parts of the coast of this fjord, and in the neighbourhood of the North Fjord Nordenskjöld collected a large number of triassic fossils, among them large nautilus-like shells and fragments of bones, some of which were thought to have been four feet long, belonging to crocodile-like animals. While in Ice Fjord, the expedition met with Mr. Birkbeck's yacht *Sultana*, "a beautiful but fragile nutshell," having among others on board, Prof. Newton. Here also a water-mark was fixed. After leaving Ice Fjord, the *Axel Thordsen* succeeded in reaching Stans Foreland, a large island to the south-east of the main island, having on its south the Thousand Islands.

"Fortunately it appeared that the discouraging descriptions of the fogs prevailing here are properly applicable to the Thousand Islands, comparatively clear weather, on the contrary, being common in the inner part of the fjord. Here, as at many other places on Spitzbergen, may be found cloudless skies and sunshine, while an impenetrable fog lies at the mouth. The cause of this is to be sought for in the course of the marine currents. While an arm of the Gulf Stream, as the masses of drift-wood heaped up at South Cape and the Thousand Islands show, at least during a portion of the year, flows past the southern part of West Spitzbergen and Stans Foreland, it is the Arctic current entering from Helis Sound and Walter Thymen's Strait, which principally prevails in the interior of Stor Fjord. There is, therefore, no drift-wood to be met with on the shores of this fjord, on which account it is necessary on boat voyages to carry a supply of fuel. During boat voyages along the north coast of Spitzbergen one may, on the contrary, nearly always reckon on finding in the neighbourhood of the resting-place dry and excellent material even for a large log fire."

The west coast of Stor Fjord is occupied by enormous glaciers, which go down to the sea and are only interrupted by black, often conically-shaped mountain tops. On the east coast, on the contrary, between Whales' Point and Helis Sound, there is only a single considerable glacier, the coast being formed of a continuous rocky wall, which rises almost directly from the sea to a snow-free plateau of about 1,000 feet in height. At the foot of this wall there are here and there grassy slopes, which form the finest reindeer grounds on Spitzbergen. The west coast both of Stans Foreland and of Barents Land was examined as far north as the extremity of the fjord. In connection with this part of the expedition's work, some interesting remarks are made on the character of the Spitzbergen glaciers:—

"When icebergs are spoken of in the region of Spitzbergen, it ought to be remembered that what is meant is large blocks of ice which fall down from the perpendicular sea faces of the glaciers. Though these blocks are often exceedingly large, they cannot in any way be compared with the icebergs in the Greenland waters, which are said to reach a height of 1,000 feet. The glaciers on Greenland near the sea are indeed higher than on Spitzbergen, but this dissimilarity is not sufficiently great to explain the great difference in the dimensions of the glaciers at the two places. There is great probability in Prof. Edlund's hypothesis that the larger icebergs are formed by blocks of ice falling down from a glacier coming in contact in their lower parts with an over-cooled stratum of water which, as is well known, in contact with actual ice immediately assumes the solid form. For any such over-cooled stratum of water can, on account of the Gulf Stream, only exceptionally occur on the coasts of Spitzbergen, while the contrary is the case in the waters of Greenland, which are taken up almost exclusively by the Arctic current. The ice seeds which have fallen from the glaciers thus find only at Greenland a suitable soil for their further development, only there do they grow to enormous ice-masses, which are so often the cause of the navigator's astonishment and alarm."

(*To be continued*)

HERING'S THEORY OF THE VISION OF LIGHT AND COLOURS

A FEW years ago Herr Ewald Hering, Professor of Physiology at Prague, communicated to the Imperial Academy of Sciences at Vienna a series of six papers propounding a new explanation of the physiology of vision, so far as concerns the perception of light and colour. The papers were subsequently collected and published in a separate form,[1] and have had a wide circulation. The author is well known by his researches on various physiological subjects, and has long devoted attention specially to the phenomena of vision, many of his views having been discussed at much length in Helmholtz's "Handbook of Physiological Optics," published between 1856 and 1866.

The principles developed in the papers in question have attracted much attention on the Continent, and, it is believed, have been thought well of by many competent authorities. So far as I know, however, no account of them, beyond meagre notices of a few lines, has yet been made accessible to English readers. It is highly desirable, both for the reputation of the author and for the information of those of our countrymen who are interested in the subject, that this want should be supplied, and I propose now to offer to the readers of NATURE an abstract of Prof. Hering's theory, sufficiently explicit to enable its general nature to be understood, but at the same time not so full as to supersede reference to the work itself by those who desire to appreciate the reasoning more thoroughly.

The theory of the perception of light and colours at present best known and most generally adopted, is the one formed on the views of Thomas Young, and further elaborated by Helmholtz in his great optical work—hence called the Young-Helmholtz theory. That which Hering proposes to substitute for it may rather be considered as an extension and an improvement than an opposing theory, inasmuch as its chief aim is, by the introduction of additional elements, to account for phenomena which, according to the previous hypotheses, are left obscure, or receive insufficient explanations. This consideration will insure for the theory a more favourable reception than if its object were completely to overturn received ideas. It is not, however, intended here to offer any discussion of the theory; we have only to state what its general features are.

In the first place, it should be explained that the theory is developed chiefly in regard to the vision of black and white, and their mixture, gray. The subject of colour is introduced afterwards, following out the same principles.

The reasoning is founded for the most part on a class of visual phenomena of a subjective nature, such as the effect of contrasts, appearances after looking steadfastly at objects, and so on. These phenomena have long been considered important in regard to the theory of vision, and they are treated of by Helmholtz at much length. The author, however, contends that the endeavours made to explain them have been hitherto imperfect, inasmuch as it has been necessary to call in for this purpose the aid of psychological considerations, such as the effect of imagination and other causes of deception. As he expresses it, on every other page of a professed treatise on physiological optics, one finds the mental judgment invoked as a *deus ex machinâ* to explain any sort of diffi-

[1] "Zur Lehre vom Lichtsinne." Sechs Mittheilungen an die kaiserl. Akademie der Wissenschaften in Wien. Von Ewald Hering, Professor der Physiologie in Prag. Zweiter Abdruck. Wien, 1878.

culty. He objects to this, alleging that these phenomena ought to be capable of purely physiological explanations, and he considers that, when properly investigated, they afford the best means of determining the true character of light-vision.

Acting on this idea, he devotes his first three papers to an examination of these subjective phenomena. He describes a series of experiments of great simplicity, illustrating the various points of importance, and he founds upon them, as he goes on, a chain of reasoning which leads up eventually to the statement of his doctrine. It will be necessary briefly to notice this introductory matter.

The first paper treats of what the author calls "Successive Light-Induction," which he illustrates in several different ways.

If you look steadfastly for, say, fifteen seconds to a minute, at the centre of a small white circular disk, laid on a large black ground (white paper on dull black velvet is best), then, closing and covering the eyes, you will soon perceive a negative after-image (*Nachbild*) of what you have seen. The disk itself will appear dark, generally much darker than the general visual area, and will be sharply defined, but it will be surrounded by a peculiar "light-space" (*Lichthof*), brightest close to the disk, and becoming gradually darker as it recedes, until it fades into the general dark area around. The appearance is that of a halo, or more exactly that of the sun during a total eclipse, where the intensely black circle is seen surrounded by the corona.

This phenomenon is usually explained as follows:—There is a certain internal light-stimulus which acts when the eyes are closed; but the part of the retina which has been exposed to the bright light from the disk has become fatigued thereby and is less sensitive to the internal light-stimulus than the parts around; so that the fatigued circle appears darker than elsewhere. This explanation, which is purely physiological, answers very well so far as the disk is concerned, but it gives no account of the surrounding light-space, for which the psychical *deus ex machinâ* is called in, it being asserted that the halo is only a mental delusion caused by the contrast between the dark circle and the less dark space around. The author objects altogether to the sufficiency of this suggestion, and has devised an experiment to show that the appearance of the light-space is a real and not an imaginary one.

He proves that when the light-spaces of two neighbouring dark negative after-images are superposed, they cause an increase of brightness. To show this, cut out two squares of white paper and place them side by side on the black ground, leaving a small interval between them. Observe then, as before, fixing the eyes steadfastly on a point in the black interval. In the after-image it will be noticed that the narrow intervening strip is much brighter than the space around the other three sides of each square, showing the effect of the superposition in that place of the two light-spaces together.

For a further study, examine the negative after-image of a narrow strip of black paper laid on a white ground; and direct attention first to the absence of any partial darkening of the general ground close to the strip (which ought to result if it were merely the impression of contrast), and, secondly, to the intensity of the brightness of the image of the strip itself. Lastly, to prove that this brightness is far greater than can be due to the self-working inner light-excitation of the retina, an ingenious experiment is shown (easy to carry out, but somewhat lengthy to describe), by which an objective test of the strength of the illumination can be made. The negative light after-image of a black stripe is found, by direct comparison, to be much brighter than a certain amount of objective light thrown on a fresh and unused part of the field of vision, proving, therefore, that the former must be due to something more than the mere unfatigued inner light of the retina.

In concluding this paper the author gives some general conclusions from these experiments. From an analogy with certain effects of colour, he names the light produced in the after-image, around a dark area, *induced light*, and the general effect *successive light-induction.* This takes place on any part of the retina where there has, in the object originally looked at, been a boundary between light and dark, the light part inducing an impression of light in the neighbouring part, so that when the eyes are shut the latter appears bright. The induced light is naturally most powerful in the immediate neighbourhood of the boundary, and diminishes as the distance from this increases, until it fades into the general aspect of the visual field. The author draws two important conclusions from this part of the investigation: (1) that the activity of one part of the retina corresponds with that of others, the usual idea of the independence of each part being untrue; (2) that the so-called independent or inner light of the retina is capable, within certain physiological limits, of being considerably increased in intensity. The phenomena of light-induction are subsequently examined more fully from a more general point of view; in the meantime it is considered as sufficiently shown that the ordinary fatigue theory is not sufficient to explain the appearances observed.

The second memoir is on "Simultaneous Light-Contrast." The author begins with the simplest example:—If a strip of gray paper is placed alternately against a black and a white background, in the former case it will appear much lighter than in the latter. The psychical theory explains this as a false mental judgment, assuming that the absolute sensation conveyed by the gray paper to the eye is the same in both cases. The author controverts this, insisting that the impression is, as a matter of reality and not of imagination, different in the two cases, which he proves by the following experiment:—Make a ground half white and half black, and lay two narrow strips of the same gray paper parallel to each other and a short distance apart, one on each half of the ground. The one on the white ground will look so much darker than the other, that a new-comer would scarcely believe they were both the same shade. Now fix the eyes for half a minute or a minute intently on a point midway between the strips; then close and darken the eyes and observe the after-image. The difference in luminosity of the two strips will be even greater than the apparent difference of shade in the original. And as this after-image cannot recognise any matter of judgment, but only faithfully records the actual state of the retina, it proves that the difference in shade observed was real, and not imaginary; and the inapplicability of the false-judgment-by-contrast explanation is manifest by the fact that the difference between the two strips will often remain after the background, forming the contrast, has disappeared.

The author then goes on to give his explanation of simultaneous contrast, namely, *that the light-perception of any part of the retina depends not only on the illumination of that part, but also on the illumination of other parts adjoining.* He adds that as in modern physiology it is customary to explain the varying strength of reaction consequent on a uniform stimulus, as varying *excitability* (*Erregbarkeit*), it may be said that here the effect of contrast is due to the fact that the excitability, and consequently the excitement, of one part of the retina is a function of the contemporary illumination of the whole retina, or at least of the parts immediately around.

The next step is to point out the connection that exists between the effect of contrast treated of here, and the light-induction described under the former head. The phenomena of successive light-induction showed that a part

of the retina illuminated either not at all or very faintly, but whose immediate neighbourhood was brightly illuminated, gave, in the negative after-image, a much stronger brightness than one, the neighbourhood of which was not so illuminated. The phenomena of contrast show, on the other hand, that the light-perception of a weakly illuminated part of the retina is diminished when its surrounding part is brightly illuminated. Thus the lowering of the perception of brightness (or excitement) *during* the observation of an object, corresponds to the raising of this perception in the *after-image*, so that the successive light-induction appears as the opposite or reversal (*Gegensatz*) of the simultaneous contrast-action. And the latter may be denoted as a simultaneous negative light-induction.

It is, therefore, easy to imagine an internal causal connection between both phenomena, and to consider the lowering of the light-perception (excitability) which takes place during the contrast, as the cause of the raising of the perception which takes place afterwards.

The third memoir treats of "Simultaneous Light-Induction" and "Successive Contrast." To illustrate the former, look fixedly at any point in a line dividing a black space from a white one; after looking some time you will see that the originally deep black begins to lighten into gray; the brightening is the greatest close to the division line, and diminishes farther away, but after sufficiently long observation it will extend more or less over the whole black field. A contrary effect takes place, but less prominently, in the other half, the white darkening in a similar way.

This appearance is usually explained in the following half physiological, half psychological way. From the increasing fatigue of the retina, the white sensation becomes gradually weaker, and, as a consequence of this, the contrast action between the white and the black becomes weaker, and the latter appears lighter, through the same false judgment invoked to explain contrasts generally.

To show the insufficiency of this explanation the following experiment is proposed. Put a strip of black velvet on a white ground, well lighted by a gas flame; after observing it steadfastly for a time gradually diminish the light, and it will be seen that the black strip becomes brighter, and the white ground darker, until at length the former appears actually *lighter* than the latter. If the explanation is applied to this it must be assumed that the fatigue of the retina has become so great that the moderated white produces actually a less powerful impression than the black stripe, which gives out light of very small intensity, or in other words, that the power of the retina is so crippled that a moderate light is no longer able to produce an impression equal to the inner self-illumination of the unfatigued organ. This can be also shown by another trial which is described.

A further experiment enables a direct comparison to be made. In the middle of a broad white stripe laid on a black ground, cut a longitudinal opening; this will show an internal black stripe, surrounded by a white surface which is again surrounded by a black ground: then fix the eyes on the middle of the figure, and, after observing some time, gradually reduce the light. It will soon be found that the black internal stripe appears *lighter than the external black ground*, although both are objectively equally dark, and the parts of the retina brought into action are, as it is said, equally free from fatigue.

The changes consequent on the reduction of the illumination show that the simultaneous light-induction passes over into the successive, the latter being, indeed, only a more clearly manifested continuation of the former. The connection of the three phenomena hitherto treated of may be illustrated simply as follows:—When you first observe a line of division between dark and light, the dark part, especially near the division, appears darker than it would do if the white were absent; this is *simultaneous contrast*. Continue the fixed observation a longer time, and the darkening gradually changes to a contrary effect of brightening, which also is most powerful near the division; this is *simultaneous light-induction*. Lastly, close and darken the eyes, and this brightened space continues a long time visible in the after-image. This is *successive light-induction*.

The last of the subjective phenomena treated of by the author he calls "Successive Light Contrast." It differs from the three last mentioned in that, while they all refer to the comparison of one visual space with another close adjoining, this refers to a comparison of the impressions derived from the *same* space at two successive times. The simplest example is as follows:—Put a strip of white paper on a black ground, and observe it steadfastly for a time; then let it be suddenly removed, keeping the eyes fixed on the same spot. A negative after-image will result, of a changeable character, but showing generally a space corresponding to the paper, much darker than the already dark ground. This is very striking; an inexperienced observer will be loth to believe that he can see anything darker than the blackest velvet; but there can be no mistake about the impression conveyed. The usual explanation of this is that the part of the retina stimulated by the white paper is more fatigued than the rest, and therefore, after it is removed, is less sensitive to the faint light given off by the black ground, making it thus appear still fainter. The author deems this explanation insufficient, as it is inconsistent with many of the changing phases observed in the after-image; and he describes several other experiments to support this view. He points out that the "successive light-induction," before described, may play an important part in these phenomena, but he does not attempt here to give any complete explanation of them.

It is pointed out at the close of this part of the subject that many of the experiments may be made with colours, instead of with simple light and shade, it being understood that black and white hold the same relation to each other, for this purpose, as blue and yellow, or red and green.

WILLIAM POLE

(*To be continued.*)

ALFRED HENRY GARROD

It has seldom been our lot to have to record the premature close of a career so full of promise as that which ended with the death of Alfred Henry Garrod, at his father's house in Harley Street, on Friday last, October 17. The son of an eminent physician, Dr. Alfred Baring Garrod, F.R.S., he was born in London on May 18, 1846, received a medical education at King's College, London, and in 1868 entered St. John's College, Cambridge. He graduated (B.A.) in 1871, taking the highest place in the natural science tripos. In due course he took his M.A. degree, and was elected a Fellow of his college in 1873. His earliest scientific predilections were chiefly for mathematics and physics, and the knowledge of these subjects which he acquired when a student was of great value to him in his biological researches. The mechanics of physiology was the subject to which he first turned his attention as a scientific investigator, and, while still an undergraduate, he communicated a paper on the cause of the diastole of the ventricles of the heart to the *Journal of Anatomy* (vol. iii., 1869). About the same time he sent to the Royal Society the results of an interesting series of experiments made upon himself with a view of ascertaining the causes of the minor fluctuations in the temperature of the human body while at rest, from which he concluded that these fluctuations mainly result from alterations in the amount of blood exposed at the surface to the influence of absorbing and conducting

media. These were published in the *Proceedings* of the Royal Society, vol. xvii., 1869. A series of papers in the *Proceedings* of the Royal Society and in the *Journal of Anatomy* followed, giving the result of observations upon the circulation of the blood, conducted with great ingenuity by means of the sphygmograph, aided by various modifications and improvements upon the original instrument due to his inventive and mechanical skill. It is, indeed, probable that physiology is the subject to which he would most willingly have devoted his attention had not his energies been turned to the pursuit of morphology by his receiving the appointment, in January, 1872, of Prosector to the Zoological Society. This appointment is one which, perhaps more than any now existing, comes near to an ideal endowment of research. An unlimited amount of new material is placed in the hands of its occupant there are no duties beyond those of making and recording original observations, and ample facilities are given for the publication and illustration of all the observations made. To the efficient performance of the duties of this office Mr. Garrod applied himself with great energy and zeal, as testified by his numerous contributions upon the comparative anatomy of the vertebrate animals, which have enriched the publications of the Society, from the date of his appointment to the present time. He devoted great attention to the anatomy of birds, hitherto too much neglected, and his observations upon their myology and visceral anatomy were beginning to throw some light upon the very difficult and obscure subject of the mutual affinities of the members of this class. The curious and most unexpected variations in structure often revealed in the dissection of species thought to be closely allied, soon convinced him of the necessity of far more extended and minute observations than had previously been made, and those who closely watched his work and knew that besides the observations he had had time to complete and publish, he had already accumulated a vast mass of facts, partly in notes and drawings and partly in the stores of his memory, feel most keenly how much has been lost by his early death.

His eagerness in acquiring knowledge was only equalled by his activity in imparting it to others, and he had a remarkably easy and lucid method of explaining, even to an uninstructed audience, difficult problems of physiology or anatomy. With the black-board or some ingeniously contrived diagram or mechanical illustration, he was never at a loss to make his hearers comprehend his meaning. These great and varied powers probably tempted him to overtask his strength. Not content with his work at the Zoological Society, he sought for and obtained the Professorship of Zoology and Comparative Anatomy at King's College, in 1874, and the Fullerian Professorship of Physiology at the Royal Institution in 1876. He was also appointed one of the Examiners in the Natural Science Tripos at Cambridge in 1875, and was for several years a constant contributor to this journal. In 1876, when he had but just completed his thirtieth year, he was elected a Fellow of the Royal Society.

In the simple and single-hearted devotion to the sciences he cultivated, he was without a particle of jealousy or mistrust of others, but was always anxious to assist those who were working in the same direction, and his room at the Zoological Gardens was gradually becoming the profitable resort of many of the younger workers at comparative anatomy, who were encouraged in their labours by his advice and example.

Up to little more than a year ago he was apparently in the enjoyment of vigorous health, but symptoms of the insidious disease, phthisis, which terminated his existence, then for the first time showed themselves. Through the gradual decline of his powers, and amid considerable suffering, borne with the greatest patience and calmness, he continued to the last to spend all his remaining strength in making the knowledge which he had acquired available for the instruction of those that should come after him.

W. H. F.

JOHN MIERS, F.R.S.

THIS well-known botanist, whose death took place on the 17th inst., was born in London on August 25, 1789, of Yorkshire parents. After leaving school he devoted his time to the study of mineralogy and chemistry, in which latter science he made a series of important researches, but it was only subsequently during his long residence in South America that he acquired his taste for botanical knowledge, and by making dissections and drawings of plants he became a botanist. In 1825 he paid a short visit to England and then published his "Travels in Chili and La Plata." In Brazil, where he subsequently resided eight years engaged in his professional engineering labours, he made extensive collections of plants and insects. After his return to England he was elected a Fellow of the Linnean Society in 1839 and a Fellow of the Royal Society in 1843, acting for a time on the Council of both societies. He contributed many papers of interest to the Linnean Society, and published the "Illustrations" and the "Contributions" to South American Botany. He served on the jury of the Brazilian Section of the Exhibitions of 1862, and of 1867 of Paris, and for his labours the Emperor conferred on him the honour of Commander of the Order of the Rose. His zeal and energy in his pursuits were most untiring, and he only desisted from his labours when forced by failing health in July last, since which time he gradually became weaker, till death ended his life on the 17th inst. in the ninety-first year of his age. It is understood that Mr. Miers has left his botanical collections to the British Museum.

As a botanist, Mr. Miers was most painstaking and accurate in his investigation of details. His descriptions, and especially his original drawings, afford ample evidence of this. On the other hand, his estimate of the relative value of the details he elaborated with such zeal and care was often at fault. His observation was keen and accurate, but his judgment was less to be relied on. It is on this account, probably, that multitudes of species and, in lesser numbers, genera, and even orders, proposed by him, have not been generally accepted by his brother naturalists. Mr. Miers, we believe, never adopted evolutionary views, but remained a believer in the fixity of specific types. What, however, is more remarkable is that to the last he disbelieved in the action of the pollen and of the pollen tube in the formation of the embryo plant. In this particular Mr. Miers probably stood alone among his fellows.

But whatever difference of opinion may exist as to the value of his inferences, there can be none as to the laborious accuracy of his descriptions, the fidelity and beauty of his drawings (too often spoiled in the reproduction), and the generous kindliness of the man.

NOTES

M. RAOUL PICTET has been appointed Professor of Physics by the Council of State of Geneva, at the University of his native city.

M. KRANTZ, the director of the Paris Exhibition of 1878, is publishing the lectures delivered at the Trocadero. It will consist of no less than thirty-five thick 8vo volumes, five of which have already gone through the press.

AT the meeting on October 7 of the Manchester Literary and Philosophical Society, the president, Dr. Joule, described a simple means for checking the oscillations of a telescope. It consisted of a leaden ring placed centrally about the axis of the

tube of the telescope and attached thereto by three or more elastic caoutchouc bands. He had employed two of these rings for his telescope, one placed near the object-glass, the other near the eye-piece. Their united weights were only one-quarter of that of the telescope tube, but nevertheless they diminished the time required for the cessation of vibration to one-sixth of what it was before their application.

IT is curious to see the impression which the electric light has made on two semi-civilised monarchs, the recent barbarities of one of whom at least have proved him to be little better than a savage. The King of Burmah, the papers tell us, has recently ordered a wholesale importation of electric lighting apparatus; and from a note in the last number of *Les Mondes* we learn that the Shah of Persia has had the light introduced into Teheran, showing an intelligent interest in its working under the direction of a Frenchman, M. Fabius Boital. So pleased was his Persian Majesty with the display that, *Les Mondes* states, he "decided on the creation of a palace of industry, the construction of which he has confided to M. Boital." Let us hope that the Shah will continue in this laudable frame of mind, and be led on to introduce many of the other beneficial applications of science into his ill-governed country.

MR. FRANCIS GALTON has reprinted, with some additions, an abstract of his Royal Institution lecture on Generic Images. Appended are some interesting autotype illustrations showing the result of composite likenesses of Alexander the Great and Napoleon I., and the composite result of likenesses of six Roman ladies and of eighteen criminals.

MR. R. IRWIN LYNCH, late of the Royal Gardens, Kew, has been appointed Curator of the Cambridge Botanic Garden, in place of the late Mr. Mudd.

THE following scientific missions have been authorised by the French Government for this year:—Ernst Chartre, of the Lyons Museum, is to carry out anthropological investigations in Kasan, the Caucasus, the Crimea, and Turkey; Emil Rivière, prehistoric researches in the department of Alpes Maritimes; and Paul Sárda to investigate the geology of the soil of Japan, and visit the most important mining districts.

DR. KARL RUSS, the well-known ornithologist, has, in his serial *Isis*, issued a request to all sportsmen in Germany to abstain during the present shooting season from killing hares and partridges, as he opines that in many places both kinds of game would be completely exterminated if his warning is not heeded. Sportsmen in this country would perhaps also do well to give the subject some consideration, as there is no doubt that the two species named must have suffered considerably from the unfavourable weather which prevailed during the last spring and summer.

EARTHQUAKES are reported from Klagenfurt and Grafenstein in Carinthia. At the former place a violent shock was felt on the 1st inst. at 2h. 20m. 25s. A.M. The phenomenon lasted for 2–3 seconds, and was accompanied by loud subterranean rumbling. The direction in which it proceeded was north-north-east to south-south-west. At the latter place a shock was felt on the 1st inst. at 2h. 5m. P.M., also accompanied by a rumbling noise; direction, west to east. In the Chinese provinces of Shen-Si and Kan-Su earthquakes have quite recently caused much damaged. It would seem that the earthquake which occurred on Friday and Saturday, the 10th and 11th inst., extended over a far wider area than had at first been reported. Shocks of greater or less violence were felt not only all over Eastern Hungary, but throughout Transylvania, Servia, Roumania, and even Bessarabia. The phenomenon manifested itself in Belgrade at half-past four in the afternoon of the 10th, and lasted eight seconds, the direction of the motion being north-north-east and south-south-west. In Weisskirchen there were two violent shocks felt on Friday afternoon about a quarter before five o'clock. Further shocks were experienced at half-past seven, and again on Saturday morning at a quarter to five, and all through the night slighter quakings and oscillations of the earth were constantly being repeated. A large number of chimneys were thrown down, and a number of houses were cracked and otherwise damaged at this place. From Temesvar it is reported that a number of shocks, one rapidly succeeding the other, were felt, the ground oscillating under foot. The shocks in Karansebes were so violent as to dash plates and dishes from their shelves to the ground, while to people in the street the ground appeared to rock with an unsteady motion like that of a vessel on a rough sea.

WE have more than once remarked on the extreme incompleteness of the indices to that most valuable journal, the *Quarterly Journal of Microscopical Science*. The index to the new volume (xix.) is not even as complete as the table of contents. It is in the interest of both zoology and botany that we make these remarks.

M. EDOUARD SARASIN has recently established a registering limnimeter, similar to those of MM. F. A. Forel and Th. Plantamour at Geneva, in a locality close to Vevey, near the eastern extremity of the Lake of Geneva. Several observations which he has made since the establishment of the instrument fully confirm the results of the investigations of Forel on the state of permanent oscillation of the fluid mass. The times of maxima and minima of the height of the water coincide with those which are observed at Geneva, showing their predicted alternation, and following an analogous period of seventy-eight minutes.

THE establishment of the electric light at the British Museum appears to have been successful. Eleven lights in all have been fitted up, and of these four are placed in the reading-room, four in other parts of the building, and three outside it. The four in the reading-room are placed, one in the centre and three equidistantly around it. They are supplied with continuous currents, each from its own Siemens dynamo-electric machine. Of the lights in other parts of the Museum, two are placed in the entrance-hall, one in the reading-room corridor, and one in the Greek gallery. In the courtyard in front of the building are two more lights, while another is placed in the rear, near to the engine and machine-house. These seven lights are supplied from one Siemens machine, producing an alternating or divided current. It will thus be seen that two different systems of electric lighting are employed, both, however, being on the Siemens principle—the four lights in the reading-room being produced by continuous currents, and calculated to be each equal to 4,000 candles, the seven other lights, which are estimated at 400 candles each, being produced by an alternating current, and being connected in one circuit about 1,200 yards in length.

THE Indian Museum will be finally closed to the public on Saturday.

THE laying of the new cable from Marseilles to Oran, in Algeria, has been attended with several mischances. The operation has been executed in a singular manner. The *Dacia* laid down the land cable from Algiers and steamed to Marseilles, in order to begin the operation from France. The end of the land cable had been buoyed, but when the *Dacia* tried to pick it up to connect it with the end coming from France, it broke. The *Dacia* and *Charente* tried to recover it with grapnels, but up to the present time without any other result than deteriorating the existing cable, which is now out of use; so that instead of having two cables, the capital of Algeria has none. All the messages were sent by the Bone line, which is encumbered by work, being mostly devoted to messages from

Tunis and Tripoli. We believe the cable has at last been successfully laid.

In the note in NATURE, vol. xx. p. 563, on the elevations attained by railways, mention is omitted, Mr. D. Sharp writes us, of the Spanish lines which are so remarkable in this respect. The northern line is at the sea-level at San Sebastian, but attains a height of 614 metres, between Zumairaga and Alsasua; after descending from this, an elevation of 934 metres is reached, between Briviesca and Burgos; and after a long transit, 1,359·88 metres (4,476 feet) is touched by the railway while traversing the Guadairama about thirty miles from Madrid. The line from Santander to Alar del Rey reaches an elevation of 984 metres in passing the Cantabrican chain near Reinosa, and in the distance of 33 kilometres between Barcena and Reinosa, mounts 560 metres. The southern line from Madrid to Cordova does not reach such great elevations as the North Spanish lines; nevertheless, in passing the Sierra Moreno, it attains the considerable altitude of 798 metres, or 2,630 English feet above the sea-level.

It is stated that the heavy rains in Assam have flooded part s of the country and threaten serious damage to tea prospects. Some of the gardens are reported to be looking very unhealthy and yellow.

Her Majesty's Consul at Panama reports that india-rubber has almost ceased to be an article of export from the isthmus, mainly in consequence of the great difficulty and expense of getting at the trees in the remote districts of the interior. Those nearer the coast have been destroyed by the wasteful system pursued by the natives in cutting down the trees to procure the sap.

The German Society for Cultivation and Acclimatisation of Birds will hold its fifth exhibition at Berlin on November 21–25 next. Cage-birds in the widest sense of the word, and park-birds generally will form the principal objects of the exhibition, which will also include stuffed specimens, skeletons, skins, nests, and eggs, as well as all apparatus and paraphernalia applying to the object of the Society. Those of our readers interested in ornithology who wish for further particulars should apply to Herr H. Schmidt, 32, Lothringer-Strasse, Berlin, N.

At Pritschaberg, near Nassenfus in Lower Carniola more than 4,000 Roman copper coins have recently been found. Most of them were contained in an earthen jar and many others surrounded this; the whole was imbedded in the ground close to a road and at a depth of only half a metre. The coins are tolerably well preserved and date from the reign of the Emperors Severus (A.D. 193 to 211), Gallienus (254 to 268), Claudius (268 to 270), Aurelianus (270 to 275), Tacitus (275 to 276), and Probus (276 to 282). The greatest number date from the reigns of Aurelianus and Probus. The jar and coins were evidently buried during the reign of the latter, as not one coin dating from the reign of his successor Diocletian is amongst the number.

In a recent paper to the Berlin Academy, on Progress in Knowledge of the Chemical Nature of Meteorites, Prof. Rammelsberg states that since he wrote in 1870 a paper on the Chemical Nature of Meteorites, more than twenty meteoric irons and about as many chondrites have been obtained and examined, besides some meteorites belonging to the more rare species; and he therefore thinks it desirable to make a fresh survey of the subject. He adopts Prof. Rose's classification. Among other points noticed are the discussions relating to the iron masses of Ovifak. The presence of nickel can no longer be regarded as a sure sign of the meteoric nature of iron masses. The small group of pallasites has been increased by one new member, the bronzite-pallasite of Rittersgrün (found in 1833 and recognised as a meteorite since 1861, but its true nature only determined lately by Weisbach and Cl. Winkler). Specially interesting is the occurrence of a white mineral (asmanite) consisting entirely of silicic acid, found in the Rittersgrün meteorite, as also in that of Breitenbach. A second representative of the rare meteorites which are free from metallic iron has been found in the Ibbenbühren stone (which contains Fe.3Mg). The first was the stone of Manegaum, purely bronzite. Recent researches on meteoric iron do not elucidate certain chemical differences of physically distinguishable parts, to which the earlier works of Reichenbach and Meunier referred; nor is the nature of the crystalline combination schreibersite more exactly known. (For further details we must refer to the *Monatsbericht*.)

Through a recent landslip at the Salzberg, Hallstadt, a wooden structure was laid bare, in excavation of which were found a number of bones and tools, which appear to have belonged to the period of Celtic interments at the Salzberg. Among these objects was an implement (of unrecognisable nature) with a thick blue coating, which, on examination by Herr von Hochstetter, was found to be covellin or protosulphide of copper, the interior being copper. The coat was 0·5 to 1 ctm. thick, and showed a composition of 32·81 per cent. sulphur, and 64·45 per cent. copper. Its specific gravity was 4·611. The copper below presented a much-corroded surface, and in the hollows were spherules of arragonite about 2 mm. in diameter. The conditions of eating away of the copper and complete transformation of it into protosulphide of copper were furnished (says the author) in the burial-ground containing gypsum and greatly permeated with decaying animal and vegetable remains. From the gypsum and organic remains there would be formed abundant sulphide of calcium, which would cause transformation of the copper according to the formula—

$$Cu + SCa + CO_2 + O = SCn + CO_3Ca,$$

or $$Cu + SCa + (CO_2)_2 CaO + O = SCu + 2CO_3Ca.$$

We receive from America details of the accident which terminated for this year the career of the New York captive balloon on August 16, the very day when the Paris captive balloon was torn to pieces by the wind because it had not gas enough to sustain its spherical form. The New York balloon was sent up with two persons only as a trial, and rose to 800 feet when it burst. The two passengers were precipitated to the ground, but no harm was done to them, the balloon having acted the part of a parachute. The bursting was inevitable, the balloon having been started full of gas and the neck having been fastened with a rope. The rent extended from the top to the equator.

The *Times* Paris correspondent states that at Guisseny, Finistère, a cave 15 metres long by 4 wide has been discovered under a heap of rocks. One entrance faces the sea at a height of 4 metres, and the other the land, so that it must have been well adapted for watch and defence. Below a layer of ashes were found stones laid together, human bones, remains of funeral urns, evidently Celtic, a considerable quantity of animal bones, some of them apparently of extinct species, and a stone hammer and polished porphyry hatchet.

We have received a pamphlet of fifteen pages entitled "Notes on the Flora of Hampshire," by F. Townsend, M.A., F.L.S. This consists principally of two carefully drawn-up lists or tables of plants. The first list comprises plants found on the Hants mainland but absent in the Isle of Wight or in one or more of the adjacent counties of Wilts, Dorset, Sussex, Surrey, or Berks. The second list is that of plants absent on the mainland in Hants but found in one or more of the counties referred to above. By the first of these lists Mr. Townsend points out "that of the seven floras enumerated those of Surrey and of Sussex more nearly

approach that of Hants, the former possessing 176, the latter 174 of the 242 species found in Hants mainland but absent in one or more of the adjacent floras; the maritime or coast plants being deducted, in order to compare a county not possessing a coast with one possessing such." Regarding the second list the author says:—"We should naturally suppose . . . the floras of Surrey and Sussex would again be shown to approach the flora of Hants mainland by thus possessing fewer species not found in the latter, and that the floras of Wilts, Berks, and Wight (which by the first list are shown to be most dissimilar from Hants mainland, for Wilts possesses 121, Berks 109, and Wight only 96 of the 242 species in List No. 1) would possess many more species not found on Hants mainland than would Surrey or Sussex; but the reverse is the truth, for these two last named counties are shown by List 2 to possess more species not found on Hants mainland than Wilts, Berks, Wight, or Dorset possess." The author advances an explanation for this apparent contradiction and concludes his "Notes" with "a few words on River Basin Districts," explaining why he "would choose them for showing the geographical distribution of plants in preference to civil or artificial divisions." The value of such notes as these is by no means slight; those before us, we are told by the author, have been published principally in the hope that they may be seen by competent botanists who may have it in their power to communicate additional species or perchance point out errors so that their insertion may be prevented in the flora of Hampshire, which Mr. Townsend hopes soon to publish.

The additions to the Zoological Society's Gardens during the past week include two Rhesus Monkeys (*Macacus erythræus*) from India, presented respectively by Dr. Douglas and Mr. R. C. Bonsfield; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. T. Hobbs; a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mrs. Bonamy Dobree; two Arabian Gazelles (*Gazella arabica*) from Arabia, presented by Capt. W. Bowden Smith, R.N.; a Great Bustard (*Otis tarda*) from Spain, presented by Mr. George G. Sandeman; two Chinese Tree Pies (*Dendrocitta sinensis*) from China, presented by Mr. Chas. Rice; a Common Waxbill (*Estrelda cinerea*) from West Africa, presented by Mr. J. C. Thorowgood; a Sun Bittern (*Eurypyga helias*) from South America, deposited; a Bosman's Potto (*Perodicticus potto*) from Sulymah, South-West Coast of Africa, two Crested Colins (*Eupyschortyx cristatus*) from Mexico, purchased.

THE SANITARY CONGRESS

THE Sanitary Science Congress opened its proceedings at Croydon on Tuesday under the presidency of Dr. B. W. Richardson, F.R.S., who spoke of the success which had attended the work of the Institute. In the evening a general meeting was held in the great public hall to hear the address of the president. As a sort of complement to his previous address in an ideal city, under the title of Hygeia, Dr. Richardson this year, under the title of Salutland, sketched an ideal land, polity, and people. He introduced his fancy sketch as follows:

"On the 19th of July of this year, at the home of the Father of modern Sanitary Progress, who has this moment resigned the chair to me, I met the most illustrious of now living men of science. Our conversation turned on many subjects, all of which were lighted up by the entrancing exposition which always gilds the genius of him to whom I specially refer, Prof. Owen. One subject peculiarly attracted the attention of us who listened to him as he expounded it. We had entered into a discussion on the question of the longevity and the natural duration of life of different classes of animals. With his usual scientific accuracy and industrious research, Owen had on that day estimated, from various data he had collected, the natural term of life of the curious animal, the hippopotamus. He had learned that its term of life was thirty years. He explained to us the mode by which he had arrived at that fact: how into the calculation it had been necesssary to take into account the dentition of the animal; the stages of development; the natural wearing out of the teeth; the period of gestation; the development of the skeleton into the perfection of a bony fabric, with particular reference to the combination of the epiphyses or loose ends of the bones to the shafts of the bones; and, lastly, the pathological or diseased condition of the dead animal of the species that had arrived at its full longevity, in order to determine whether or not there was evidence of cause of death from disease of some particular organ, or whether there was no such evidence, but simply a history of general decay from old age pure and simple.

"We were told that in a hippopotamus which had recently died, and which was known to have just turned thirty years of age, the two sets of teeth had fulfilled their allotted duty; that the bones of the skeleton were duly consolidated; and, that the organs of the body were equally degenerated; so that death had occurred, not from failure of any particular organ, but from failure of the organic parts altogether. In a sentence, the animal had died a natural death, and the constant of the term of life of it and its family was set down at thirty years, a constant to which all the facts that could be collated in respect to this species of animal definitely pointed.

"From this line of facts in respect to one type of animal life we were led to others, and the rule, laid down by the distinguished Flourens, by which the determination of natural old age is calculated on the basis of perfected maturity, was brought under review. The skeleton is perfected when the epiphyses or loose terminal parts of long bones are firmly united with the shaft of the bone. When the date of such perfection of development is known in the mammalian class of animals, the simple process of multiplying the age at that date by five, gives the natural anatomical life of the animal. The elephant came before us as an example. A young elephant, whose history has been related in the *Philosophical Transactions*, died at the age of thirty years. At that age the epiphyses of its bones were not completely united with the shafts. It was nearly but not quite matured. Multiply thirty by five, and one hundred and fifty years stand as the natural estimate of the life of the elephant, so that really an elephant might exist which had itself carried all the Governors-General of our Indian Empire. Moving from this animal of long life, we turned to the camel, to find full maturity at eight years, full life at forty. We turned to the horse, to find full maturity at five years, full life at twenty-five. We turned to the lion and the ox, to find full maturity at four years, full life at twenty. We turned to the dog to find, full maturity at two years of age, full life at ten. We turned to the cat, to find full maturity at eighteen months, full life at seven and a half years. We turned to the rabbit, to find full maturity at one year, full life at five.

"From these contemplations our minds very naturally reverted to the animal, man, to the members of the human family. Man, we learned, follows the same rule as the rest of living beings. Judged by the same test, his full maturity and full age may be calculated with equal precision. His maturity, —perhaps not quite the full maturity,—is twenty years. His full age, therefore, is one hundred years. This is the anatomical estimate of human life, the surest and by far the best of all that can be supplied, since it defines a law irrespective of and overriding all those accidental circumstances of social and physical storm and strife, which may interfere, and indeed do interfere, with every estimate based on the career of life itself, as it is shown in the ephemera by and through whom it is phenomenally demonstrated.

"This lesson, told with singular felicity of language from two masters of science,—for Owen never forgot Flourens,—struck Mr. Chadwick and myself with singular force. On a surer basis than we ever trod, it corroborated a view we had ourselves promulgated from entirely different stand-points; and it further corroborated a similar view which had been advanced by our eminent friend, Dr. William Farr. We were led, in a word, once again, to the inevitable conclusion that man, even in this stage of his probation on the planet, is naturally destined to walk upon it, endowed with sensibilities of life and intelligence, for a period of one hundred years, and that until he realises this destiny practically, he is in value of physical life actually degraded far below his earth-mates, whom he designates the brute creation, and over whom he presumes to exercise his, to

them, almighty will. The constant of human life is naturally one hundred years.

"In this statement I, for one, gathered up, on the occasion referred to, something never to be forgotten. The constant was before us in all its truthfulness. But more remains. Because the fulness of age is one hundred years, it is not an essential that death shall immediately crown the advent of that fulness. To certain parts of the scheme of natural life there is a boundary. The period of maturity of development has its boundary of twenty years; when the body, as Flourens says, ceases to grow; but if it ceases, in the ordinary sense of the term, to grow it does not cease to increase; its nutrition improves and perfects for twenty years more at least, and then only has reached its completed physical condition. It should never from that period gain in weight, and for a long time it should not lose. It goes on now through a third period, which Flourens admirably calls the period of invigoration, during which all its parts become firmer, all its functions more certain, all its organization more perfect; and this period covers thirty years. At seventy old age begins; the *first* old age, in which naturally the fruits of wisdom are most bountifully developed, and which lasts from fifteen years to twenty, to mellow down to a period of *ripe* old age, commencing at eighty-five years and lasting fifteen years more, *i.e.*, until the constant is attained.

"And yet there need not now be death; for though, as Lord Bacon has said, old men are like ruined towers, and though, as Flourens has quoted, youths live in a double sense, with forces in reserve and forces in action, *vires in posse et vires in actu*, the *radical* forces and *acting* forces of Barthez, while old men live only on the forces in action, '*vires in actu*,' possessing no reserve, it is wonderful how the forces in action will continue after the reserve is withdrawn. This kind of half-life has continued unquestionably many years beyond the fulness of age, both in man and lower animals, and to give it twenty years beyond the natural hundred is to be just without being in any extreme sense generous.

"In this anatomical reading of human life we see the growth, the increase, the invigoration, and the solidification, of the body: we see the life with its reserve on its two threads; the life without reserve on its one thread; and, finally,—the force in action being withdrawn—the life ceasing, and the earth, proclaiming her mastery, dragging the actor as unconsciously to herself at death, as he was unconsciously projected into the world at birth.

"All through this presentation of natural fact, moreover, there runs another physical truth. Death is centripetal action. Those two birds on the wing which up to heaven's gate sing, are physically filled, like the gyroscope, with the *vires in posse et vires in actu*, powers in reserve and powers in action. Yon wanton sportsman liberates a ball which pierces one bird, and the earth claims its prey. The living gyroscope falls. The fellow bird escapes. In time, it fails to rise to the same height, its force in reserve being withdrawn, but its force in action remains, and it lives on. At last, some trifling extra call upon it is final, and the triumphing earth brings it down to itself. That first bird fell from an interference with its life while yet it had its two powers; that second bird fell from failure of powers at different periods, but from the same inevitable, always present cause, the attraction of the earth.

"The same is true of men also. What we call death is gravitation: what we call disease, is some accidental shot inflicted, it may be, while still the self-resistance to gravitation is in operation: what we call natural death is the gradual overweighting, at different periods, of the natural powers, reserve and acting, by the persistent force that bears us down. We cease to grow at a certain stage of our life, because of the resistance of this downward force: we cease to increase in size from the same cause: we consolidate in structure from the same cause: we bend in old age from the same cause: and we die from the same cause. Every step has practically been a death from the same cause.

"As these facts appear, we are inclined to ask, How many of all men and women projected into life and charged with the reserve and acting forces,—how many die with these forces intact up to the time of death, and how many with the acting force alone in operation? How many, if I may use the simile, die on the wing, fall headlong to the earth, shot by some wanton shaft that need never have been discharged? How many sink naturally to the earth from her final and gentle embrace?

"The answer to this question appals the mind. The answer rings out:—Man reckless of life! every lower animal you do not immolate beats you in this! Man! civilized as you are proud to say, you have never yet given life a chance! Man of reserve and action, you die on the wing more certainly than the birds of the air on which you practise your fatal sports! You die within the first part of the second third of your natural lives. Let the elephant die at sixty, the camel at sixteen, the horse at ten, the dog at four, the cat at three years, and the rabbit at two years, and they will then match you in the value of life you train yourself to possess. Man, endowed with knowledge of science, who can divide the year into seasons, and history into centuries and eras; who can calculate the courses of the planets and predict their crossings and shadows; weigh the earth, as in a balance, and predicate storms and tempests, you have yet to learn that, with the precision that regulates all these things, your own life is meted out,—that such a childhood means such an adolescence, such an adolescence such a maturity, such a maturity such a decline, and such a decline such a periodof death.

Nay more; man so endowed does sometimes see by adventure, as it were, the whole law fulfilled without his studying for it or expecting it. Some individual lives the whole natural period of life, exceptionally, as an elephant, a horse, a lion, a dog, a cat lives it ordinarily, and thus by adventure, proves the truth of the law which has been laid down. The event, perfectly commonplace in the case of a lower animal,—a dog that lives to ten,—is a perfect marvel when it happens to a man who lives to a hundred years, the equal term. To see a centenarian we travel miles and miles, and discuss the time of his birth with keenest criticism, so truly unnatural is the state of things under which human existence at present is unfulfilled.

"The question arises, How long is this condition of affairs to last? No more vital question stands for solution at the bar of civilisation.

"The day, in fact, has now arrived, when the cultivation of life by the cultivated of mankind is the primary art for the continuance of the cultivated. If the civilised world would continue in the ascendant, it must learn to live. An average life of forty-one and under favourable circumstances of forty-nine years, with a world of disease and death up to that period, and a scattered struggle of the fittest for an exceptional existence into ripe old age, cannot maintain the relative efficiency of any nation, except in a world universally and equally bad. Ingenuity itself is bounded by life; device by faculty for devising. Weapons of precision give us victory over savages. Is that success? Weapons are made, not begotten, and savage tribes, fierce for contest and unscrupulous, may readily learn to apply what the civilised man has devised, and in repetition of history, make easy work of the short-lived civilised.

"We Sanitarians are forced by our studies to recognise these truths. We exist, if we exist for any great purpose at all, to protest against the casting away of nearly two-thirds of the life that is meted out for civilised men. We exist to protest that it is not a scientific civilisation which can permit such reckless waste of the gift that stands above all values and qualities; and our protest is the more earnest as we detect that the waste which we observe, is actually not at the time of life after the prime has been reached, but is most destructive in the very budding of life, and continues at the intermediate stages between the period of budding and the prime.

"To speak in plain terms,—and if ever plain terms were demanded, they are demanded now,—the world in this matter of life and death has, by daily observation of the phenomena, got into the habit of looking on wrong as right, and on what is practically suicidal death as death that is natural. It is a strange fatuity. If we were, for a short time, to see the lower domestic creatures under the same curse; if we were to witness horses enjoying ten, dogs four, and cats three years, as an average duration of their lives, we should think a persistent murrain had come upon them, and that, in relation to these useful domestic animals, the whole course of life had undergone a deteriorative change. Yet that is what, in effect, we are observing amongst our own kind, so that the Sanitarian in despair may exclaim: 'Oh that man were as wise as the horses and dogs, that he might have the bounty of life which the Allwise has awarded to him as the natural bounty, extended and beautified and exalted by the intelligence with which he is endowed above the beasts.'

"I press the question. Why should we, of all animals, perish as we do in the first part of the second third of our

natural career? Why are all the doctors of the human species, with their flowing knowledge and consummate skill, to carry out cure? Why are they so set at naught, that the lower animals, who have no advantage of their services, have a higher vital possession than man at their command?

"The answer is told in a few words. It is that we have never as a community let ourselves study the question; have never, in truth, looked at the facts, plainly as they stand forth.

"And now comes another question—Knowing the facts; knowing what is the natural term of human life, can mankind learn to attain that term? Can man learn to live his hundred years, with a prospective chance of extension to a fifth of a century more? Instead of being cut down at the moment when he has filled his intelligent mind with the learning of his time, and when his knowledge is just becoming transmutable into wisdom, can he go on, an intellectual being, brought to the highest pitch of usefulness? Can he go on to the full term of his natural and prospective course?

"I do not dare answer that question on my own account, because it is answered for me. He who gave the life has answered the question. He has written it for us in unmistakable language. He has shown all of us who can read His natural designs, that it is one of them that man may live the term if he will. Free-will making a man a free agent, is all that is set above the natural law, and free-will is natural law too, government by intelligence which is as natural, and is as freely supplied.

"How, then, shall civilised man live, that the natural term may be found?"

Dr. Richardson then proceeded to sketch his ideal Salutland, located somewhere to the extreme south of Mr. Hepworth Dixon's "New America," the time being the middle of the twenty-first century. He depicted its polity, its social and domestic life, its people, its work, its sanitary arrangements.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE ninth session of the Newcastle College of Science was opened on the 13th inst., when very satisfactory reports of the progress of the institute were made. Prof. Lebour delivered the inaugural address on Some Aspects of Geology. Interesting and genial speeches were given by Lord Ravenworth, the Dean of Durham, and others.

FROM the Calendar of Anderson's College, Glasgow, we see that a very complete education can be obtained at that institution in science and medicine, the fees being unusually low. The Calendar has an interesting sketch of the life of John Anderson, F.R.S., the founder of the college, as also of the institution itself.

M. FERRY, the Minister for Public Instruction, having arrived in Paris, has visited the Observatory and the School of Medicine, where important works are being carried out. One of the peculiarities of the new buildings will be the large number of dissection rooms. More than a hundred tables will be prepared for dissections, so that every student in medicine will be enabled to take part in *épreuves pratiques*, which will be an essential part of the education of medical students.

THE new college so liberally endowed by Mr. Mark Firth, at Sheffield, was opened on Monday by Prince Leopold. The endowment, it is expected, will soon reach 25,000*l.*, and the institution is mainly intended for carrying out the University extension scheme, which has been remarkably successful in Sheffield. The building seems to be altogether satisfactory, and, we are glad to see, contains provisions for experimental instruction in chemistry and physics. Prince Leopold insisted on the great benefits which must accrue to the working classes from the establishment of such an institution.

PROF. MAX MÜLLER, on Monday night, delivered the president's inaugural address on the opening of the winter session of the Birmingham and Midland Institute. His German and Italian friends, he said, while recognising that full political liberty reigned here, thought there was little intellectual freedom, and that, however it might be in London and a few other large cities, the Universities—the nurseries of thought and learning—were fettered by the mediæval spirit of monastic institutions and the principles of scholastic philosophy, which contrasted ill with the freshness and freedom of Continental Universities.

SCIENTIFIC SERIALS

The Quarterly Journal of Microscopical Science, October.—W. B. Scott and H. F. Osborne, On some points in the early development of the common newt, with pl. 20 and 21.—E. Ray Lankester, On the structure of *Haliphysema Tumanowiczii*, with pl. 22, generally confirming the facts recorded by Mr. Saville Kent, and failing to observe the collar-bearing flagellate cells described by Haeckel. Prof. Lankester shows the structure to be however not quite so simple as that which is supposed to characterise the body substance of such Foraminifers as the Lituolida.—E. Ray Lankester, On a new genus and species of Gymnomyxa (*Lethamœba discus*) pl. 23.—H. Gibbes, On the structure of the vertebrate spermatozoon, pl. 24.—Index to volume xix., N.S.

The American Naturalist, September.—Brazilian corals and coral reefs, by R. Rathbun.—The formation of Cape Cod (concluded), by W. Upham.—The hillocks or mound-formations of San Diego, California, by Dr. G. W. Barnes.—Insect powder, by W. Saunders.—Recent literature; General notes; Scientific news; Proceedings of Scientific Societies; Selected articles.

Journal de Physique, September.—M. Bouty here describes some mechanical phenomena which accompany electrolysis; his paper treats (1) of pressures exerted by galvanic deposits, (2) of the action of heat on metallised thermometers, and (3) of peculiarities of nickel.—M. Sebert gives an account of the accelerograph of M. Marcel Deprez, in its most recent form; the apparatus is for measuring pressures developed by gases from powder (which are caused to act on a piston).—There are also notices of M. Deprez's magneto-electric machine (in which a Siemens armature is arranged to work between the branches of a horse-shoe magnet, being about equal to these in length), and a new form of electroscope, by M. Guerout.

Asiatic Society of Bengal, vol. 47, No. 223, N.S., April 6.—Description of *Thaumantis louisa*, pl. 12, from Upper Tenasserim, by J. Wood Mason.—On a great snow-fall in Kashmir, by R. Lydekker.—Physiographical notes, &c., on Tanjore, by Lieut.-Colonel B. R. Branfell.—On the proper relative sectional areas for copper and iron lighting rods, by R. S. Brough.—Description of a new Homopteron (*Cosmoscarta masoni*), by W. L. Distant.—On the Indian species of the genus Erinaceus, by Prof. Dr. Anderson, with 4 plates.—On a supposed new hedgehog (*Erinaceus niger*) from Muscat Arabia, with a plate.—On *Arvicola indica*, Gray, and its relations to the sub-genus Nesokia, with a description of the species of Nesokia (pl. 13 and 14), by Prof. Dr. Anderson; Index to Volume.

Morphologisches Jahrbuch, Bd. 5, Heft 2.—A. Pansch, Memoir on the morphology of the cerebral hemispheres, in mammalia, pl. 14 and 15.—H. Strasser, On the development of the limb cartilages in Salamanders and Tritons, pl. 16-19.—G. v. Koch, Notes on the skeleton of corals, pl. 20.—M. Fürbringer, On the question of the formation of nerve plexi, pl. 21, 22.—C. Semper, Reply to Prof. Fürbringer's article "On Homology." —Prof. Fürbringer, On the chief points alluded to in Prof. Semper's reply.—Notices.

Zeitschrift für wissenschaftliche Zoologie, Bd. 32, Heft 4, August.—On the worm fauna of Madeira, by Prof. Langerhans, pl. 31-33. Describes a large number of new genera and species.—Researches into the structure and development of the Sponges, seventh notice: The family of the Spongidæ, by Prof. F. E. Schulze, pl. 34, 38.—*Typhloscolex mülleri*, W. Busch, being a supplement to notes on the pelagic annelids of the coasts of the Canary Islands, by Prof. R. Gree^c, pl. 39.—On the oral skeleton of Asterids and Ophiurids, by Dr. H. Ludwig.

SOCIETIES AND ACADEMIES

LONDON

Entomological Society.—October 1.—Sir John Lubbock, Bart., F.R.S., president, in the chair.—The President alluded to the loss which the Society had sustained by the death of Mr. Wm. Wilson Saunders, F.R.S., and a former President of the Entomological Society, and announced that the council had accepted the responsibility of awarding two prizes offered by Lord Walsingham and other gentlemen for the best and most complete life-his-

tories of *Sclerostoma syngamus*, Dies., and *Strongylus pergracilis*, Cob., supposed to produce the so-called "gapes" in poultry and other birds, and also the grouse disease. Messrs. Stainton and McLachlan, both objected to the Society dealing with subjects relating to the *Entozoa* which could in no case be considered as entomology, for the study of which the Society was founded, and considered that the matter would have been more properly placed in the hands of the Linnean or Zoological Societies.—Mr. Philip Hy. Gosse, F.R.S., of Torquay, was elected an Ordinary Member. —Mr. McLachlan exhibited specimens of the hemipterous insect, *Anthocoris nemorum*, reported to be doing great damage to hops growing in the neighbourhood of Canterbury, but the exhibitor suggested that it was on the hops in search of aphides or other small insects, and therefore beneficial to the hop-grower. He also exhibited examples of the larvæ of one of the *Embidæ* found by Mr. Wood Mason at Jubbulpore. Mr. McLachlan further called attention to the sculptured stones on the shores of Lake Leman, previously referred to and considered by Prof. Forel to be due to the action of trichopterous larvæ. From a recent examination of many similar stones on the shores of Lake Neuchâtel Mr. McLachlan inclined to the opinion that the markings were caused by Mollusca.—Mr. Pascoe exhibited a specimen of a species of the *Acridiidæ* remarkable for its aquatic habits, which was found in some numbers on the surface of a pool near Pará.—The Rev. A. E. Eaton exhibited larvæ, pupæ, and cases of species of *Hydroptila* (restricted) collected in the neighbourhood of the Haute Savoie, describing their habits and referring to a case of synonymy to which they had given rise.—Sir John Lubbock exhibited a specimen of *Orchesella rufescens* taken in Kent, being a species of Collembola new to Britain.—Mr. E. Boscher exhibited a coloured drawing showing the extreme forms of two varieties of the caterpillar of *Smerinthus ocellatus*, and remarked on their food-plants and habits.—The following papers were either read or communicated :—"Descriptions of Phytophagous Coleoptera," by Mr. J. S. Baly; "Descriptions of New Sphingidæ," by Mr. A. G. Butler; and "On the Affinity of the Genus *Polyctenes*, West, with Description of a New Species," by Mr. C. Waterhouse.

Royal Microscopical Society, October 8.—Dr. Beale, F.R.S., president, in the chair.—Prof. Martin Duncan and four other gentlemen were elected Fellows, and eleven nominations were made for the November meeting.—Several valuable donations to the Society were announced, consisting of a revolving table, a ruling machine, and a clock, and of books, apparatus, and slides, for which special votes of thanks were given to the donors.—Mr. J. Beck read a paper on the structure of the scale of a species of *Mormo*, Mr. Gilburt on the morphology of vegetable tissues, and Dr. Stolterforth on a new species of the genus *Eucampia*.—In the discussion on the papers the President, Mr. Stewart, Mr. Beck, Mr. Gilburt, Dr. Edmunds, and Mr. Crisp took part.

PARIS

Academy of Sciences, October 15.—M. Daubrée in the chair.—The following papers were read :—On the present state and the future of thermo-chemistry, by M. Berthelot. The author presented his new work, "Essai de Mécanique chimique fondée sur la Thermochimie," comprising the matter of some 300 memoirs published in the *Annales de Chimie*, &c. The first of the two volumes treats of calorimetry: its first part expounding the theoretical rules, its second experimental methods, while its third contains numerical data accumulated during the last sixty years by physicists and chemists, on heats of combination and of physical changes and on specific heats. The first part of the second volume comprises the general study of chemical combination and decomposition, and principally that of systems in equilibrium between two contrary tendencies. The next part deals with the fundamental object of the work, the prevision of reciprocal actions of substances, and the rules by which it is determined, which are deduced from the principle of maximum work. This simple principle separates effects due to chemical energies, between particles of ponderable matter, and foreign energies between ponderable matter and the etheric medium. This separation is (in the author's opinion) the chief original feature of the work. The prevision of phenomena, from numerical data of thermo-chemistry seems to him destined to work great changes in chemical science.—Regular alignments of joints or diaclases, in the tertiary strata of the environs of Fontainebleau; their relation with certain features of relief of the ground, by M. Daubrée.—M. Marey announced, by letter, that he had received an electrical Gymnotus alive from Para. Having recovered from the fatigues of the voyage, it now gives strong discharges when touched; it also grows tame and eats gudgeons offered it. It is placed in an aquarium at 25° C. The discharges are not so violent as those of a gymnotus received last year, which, wounded and ill, died soon after being experimented with, and which was probably frightened and angry when touched.—The President announced, with regret, the death of M. De Tessan, Member of the Section of Geography and Navigation.—Production of a new manure capable of meeting the requirements of agriculture, by M. De Molon. He utilises wrack or seaweed, mixing them, in successive layers, in pits, with pulverised phosphate of lime, in proportions suitable for fermentation. The mixture is allowed to ferment six weeks to two months, according to the season, and if the decomposition of organic matter is not completed then, the compost is mixed anew for further fermentation. The manure thus produced contains, besides phosphate of lime, rendered very assimilable, the fertilising elements, nitrogen, mineral salts, potash, soda, and magnesia.—A note by General Ibañez, accompanying the second volume of "Memoirs of the Geographical and Statistical Institute of Spain," was presented. —On the separation of roots of an algebraic equation with numerical coefficients, by M. Laguerre.—Experiments on the electric discharge of the chloride of silver battery, by Messrs. Warren de la Rue and Müller.—Action of metallic nitrates on monohydrated nitric acid, by M. Ditte. Certain nitrates combine with the acid named to form acid salts. Others (of which nitrate of magnesia is a type) are fused, under heat, in their water of crystallisation, which is then liberated along with nitric acid, and there remains a matter containing still more or less water, neutral nitrate, and either a sub-nitrate or an oxide. On contact with the monohydrated acids, the sub-salts are changed into neutral nitrates, setting at liberty some water, which is added to what the matter still contains, and which cannot be separated without decomposing the matter entirely. (The nitrates of manganese, zinc, alumina, iron, copper, and manium, also belong to this group). A third, and the largest group of nitrates, are simply insoluble or extremely little soluble in the acid considered. Nitrate of lead may be taken as a type.—On nitrate of silicium, by M. Schutzenberger.—On the physiological action of *Strychneæ* of South America, by M. Jobert. He has tried several of these, and finds they all act similarly; they are not tetanising, like the strychneæ of Asia. They quickly affect the motor-nervous system, not affecting the sensibility and the circulation. —On the treatment of sympathetic ophthalmia, by section of the ciliary nerves and the optic nerve, in place of removal of the eye, by M. Boucheron.—On the innervation and circulation of the breast, by M. Laffont. The breast contains true dilator nerves, as well as those which, when excited, cause increase in the quantity of milk secreted.—Origin and morphological value of the different pieces of the labium in Orthoptera, by M. Chatin.

CONTENTS

THURSDAY, OCTOBER 30, 1879

STERRY HUNT'S CHEMICAL AND GEOLOGICAL ESSAYS

Chemical and Geological Essays. By Thomas Sterry Hunt, LL.D., F.R.S., &c. Second Edition, revised, with Additions, pp. 489. (London: Trübner and Co., 1879.)

THIS book contains twenty essays, and a preface, itself an essay, some of which were written as early as 1853, and the others have appeared from time to time, either as original contributions, reviews, or lectures. These literary and scientific efforts are but a small part of Dr. Sterry Hunt's contributions to chemical and dynamical geology, but it would appear, from the preface to the first edition, that a selection was made upon a definite idea. The selected essays, as a whole, cover, he considers, nearly all the more important points in chemical geology; and the introduction of one relating to the hypothesis of a cooling globe and of "certain views" of geological dynamics, he considers make together a complete scheme of chemical and physical geology. He was disposed to re-write some of the essays, but this was not done, because they seem to the author to have a certain historic value and serve to fix the dates of the origin and development of views, some of which, after meeting for a time with neglect, or with active opposition, are now beginning to find favour in the eyes of the scientific world. Dr. Sterry Hunt states that his views, for which his fellow-workers were not prepared, were subsequently propounded by them as new discoveries or original conclusions. Five of the papers, moreover, contain, according to the author—writing in 1874—the germs of a philosophy of chemistry and mineralogy which he hopes one day to develop himself or to see developed by others.

There is no doubt that, although Dr. Sterry Hunt may be satisfied that his views are correct on all the very numerous subjects he has entertained, there is not a single chapter, one might say a single page in many, which will not meet with very decided opposition on the part of scientific men who are not likely, in after years, to let their hypothetical conversion precede their assumption of originality.

It is difficult in reading this book, full of good facts, but crammed with hypotheses and arguments about priority of thought, to believe that the author is a most genial man, and who is imbued with the true spirit of science. Very much of the type of the late David Forbes, he really is the last man whom one would believe would be so dreadfully polemical. Yet he must know that the book can only be appreciated by advanced geologists and chemists who really do care that the discoverer of a *fact* or of a *method* should have a proper priority, but who do not care about who first put forward certain *views* on subjects incapable of proof or indulged in scientific *guesses* before the fact. There is no doubt that with regard to a science like that of geology, men working in different countries at the same subject, arrive simultaneously at the truth or what seems to be true in relation to facts which are common property. A register of opinion, whether expressed at lectures, debates, addresses, or published in journals, is clearly impossible. Moreover, there is a great amount of unwritten geology which is common knowledge, but no one thinks it worth while to write it and claim a priority. Hence any one taking up a variety of subjects must suffer from not having his ideas recognised at once and may really be unfairly placed in the background. But as there is usually no intention of an evil character, it is unwise to be so very touchy upon priority in hypothesis. Very characteristic of certain zealous minds, is this everlasting harping on who made the discovery of a fleeting hypothesis first.

On looking over these essays we are struck that whilst a controversy with Dana is recorded, the celebrated reply of David Forbes to some of the author's views is not given. And some of the contributions seem to represent former views of the author, and not those which he has since developed. Mallet will feel uncomfortable when he reads how he has been forestalled in his kinetic theory, but it is satisfactory to have the cap put on the right head. Dr. Sterry Hunt has settled volcanicity, and may be thus quoted: "With the contributions of Vose and Mallet, the theory of volcanic action advocated by Keferstein, Herschel, and myself, would seem to be well-nigh complete." This self-commendation will, however, not establish the nonsense of Keferstein, whom the author terms irrational, or the mere passing expression, without confirmatory facts, of Vose, and it will not enable him to stand on the same footing as the philosophic and modest Mallet.

Should any geologist make an original suggestion, do not advise him to refrain from publication; or if it is to be given to the world, let it be done at once. Otherwise Dr. Sterry Hunt may suffer, as he did in the odd matter of limestones, dolomites, and gypsums, and the illustrious but reticent Cordier. On October 28, 1844, a memoir was deposited with the Academy by this geologist. Being in a sealed packet, writes Dr. Sterry Hunt, its contents remained unknown until after his death, when at the request of his widow the seal was broken. No money was found and not a codicil, but on February 17, 1862, a remarkable theory transcending everything geological and fully explanatory of the formations of those limestones, came to light. It fell flat, for Dr. Sterry Hunt had maintained similar views, or rather more correct views, for four years.

Prof. Ramsay is so hardened a debater that he will not be utterly cast down, it is to be hoped, by having one of his hypotheses snatched from him and placed on the prior brow of our author. It was not for some years that certain *views* of the author on the formation of dolomites "found recognition." "When Prof. A. C. Ramsay, by the investigation of the magnesian limestone of the Permian in England, was led to reject as untenable the notion held by Sorby (and by others) that this was once an ordinary limestone of organic origin subsequently impregnated with magnesian carbonate under conditions not explained; and to conclude that the carbonates of lime and magnesia of which it is composed had been deposited simultaneously by the concentration of solutions due to evaporation in an inland salt lake." To this view as he informs us, he (Ramsay) was led by physical considerations and "by the depauperated condition of the

organic remains contained in these strata, *without being at the time aware that I had twelve years previously announced the same conclusions for all magnesian limestones, and established them on chemical grounds.*" The italics are ours, for Prof. Ramsay's especial benefit. The author concludes his last essay on the theory of types in chemistry, with some good advice to a thoughtless-Sterry-Hunt-neglecting posterity :—" In conclusion I have only to ask that future historians will do justice to the memory of Auguste Laurant, and will, moreover, ascribe to whom is due the credit of having given to the science, a theory which has exercised such an important influence in modern chemical speculation and research; remembering that my own publications on the subject, which cover the whole ground, were some years earlier than those of Williamson, Gerhardt, Würtz, or Holbe." It is a pity that much good scientific work should be encumbered by these vanities, and really much that is objectionable can be compensated by the study of such essays as those on the chemistry of natural waters, which is admirable and suggestive.

THE PHILOSOPHY OF MUSIC

The Philosophy of Music. Royal Institution Lectures. By W. Pole, F.R.S., F.R.S.E., Mus. Doc. Oxon. (London : Trübner and Co., 1879.)

IT has long been felt by intelligent persons anxious to possess some acquaintance with the scientific side of music, that the technical works to which they have recourse for the desired knowledge are unsatisfactory from a logical point of view. We are acquainted with no work on technical music which offers any reasonably intelligent explanation of the basis on which its material is founded; and a school has arisen, no doubt partly as a reaction from the crude speculations and unsupported dogmatism of many standard works, which refuses to acknowledge anything beyond the mere acquirement of technical facility in composition as a desirable object in the study of the so-called science of music.

The work of Dr. Pole appears to be intended as a protest against this limitation. It is an endeavour to make plain so much of æsthetic and physical acoustics, and the *rationale* of technical music, as may enable the musician to give some sort of intelligent reason for the faith that is in him.

Dr. Pole's well-known musical attainments are a guarantee for the soundness of the work so far as musical technicalities are concerned. As to general questions of evolution, the nature and objects of musical grammar, the origin and nature of scales, and of the technical rules of music, we think that this book leads the way among English works, in a logical, or perhaps we had rather say, in a common sense treatment of the subject.

It is useless within the limits of this article to attempt to convey any idea of the arguments employed. For the most part the opinions of Helmholtz have been adopted. Whatever may be the ultimate opinion as to the absolute accuracy of these views, there can be no doubt that their admission changes the fundamental study of music from an unmeaning dogmatism into a science.

The first part of the work gives a sketch of the material of music, and forms a treatise on elementary acoustics. The second part deals with the evolution of melody, the history of the scale, melodic and harmonic relations, rhythm and form. The third part is entitled "The Structure of Music." Its most important items are the history of harmony, and the discussion of its rules, combinations, and progressions. It concludes with a slight notice of counterpoint. The characteristic of the book seems to be that a good idea may be obtained from it of a sound body of musical doctrine, comprising foundation, history, and technique.

We select two or three points for notice, as to all of which we are not perhaps quite in accord with Dr. Pole.

There is something yet to be said as to the difference in the way in which the highly gifted musician and the ordinary listener hear music. The observations on the decay of counterpoint (p. 288) seem to want some notice of this. It is more or less a waste of energy to write music in many parts, all of which are made melodious at some sacrifice of the harmonic effect, when not more than perhaps one in a hundred listeners is capable of hearing more than one melody at a time. We think that it is not the power of writing counterpoint that has died out so much as the will to write it. There can be no doubt that the unpopularity of counterpoint is mainly due to the fact that the ordinary listener is unable to hear in it what the highly gifted musician hears. The many simultaneous melodies are quite lost on the ordinary listener. It is only in the case of the greatest composers, whose principal melodies and harmonies do not suffer by their attention to the counterpoint, that works of this class attain any popularity. Until the acquirement of the power of hearing many simultaneous melodies is placed within the reach of the ordinary listener by a suitable and widespread education specially directed to this purpose, it is useless to look for a popular interest in counterpoint, which shall encourage the composer to produce it. There is a question how far it is possible for a person not naturally gifted with the polyphonic ear to acquire it in perfection. But there can be no doubt that systems of education are possible which will do much towards advance in this direction; and that the direct cultivation of polyphonic hearing and reading is the shortest cut towards the formation of the true musician.

There is an incompleteness in Dr. Pole's statement of Helmholtz's explanation of consonance and dissonance, which is important, as it affects the logical foundation of this part of the work, which however forms but a subsidiary portion of Dr. Pole's book. The point in question has been discussed at large some time ago by Prof. Mayer, Mr. Sedley Taylor, and others. It will be sufficiently explained by quoting the summary of the principles which Dr. Pole employs in the discussion of the examples of chords, and also a passage from Helmholtz which contains the considerations omitted.

(Dr. Pole's book, p. 210.) "Now having given these two data, velocity of beating, and strength of beating notes, we may examine some of the binary harmonic combinations of sounds, and see in what manner and to what extent the partial tones, of which the sounds are made up, give rise to the beating or harshness above described."

The following passage will show that another set of data is required, namely, the law according to which the

production of beats in the ear between pure tones depends on the interval:—

(Ellis's "Helmholtz," p. 260.) "On the other hand we have seen that distinctness of beating and the roughness of the combined sounds do not depend solely on the number of beats. For if we could disregard their magnitudes all the following intervals, which by calculation should have 33 beats, would be equally rough:—

"The semitone	*b' c''*
,, whole tones	*c' d'* and *d' e'*
,, minor third	*e g*
,, major third	*c e*
,, fourth	G *c*
,, fifth...	C G
(to which we may add the octave	C_1 C).

"and yet we find that the deeper intervals are more and more free from roughness."

Helmholtz then proceeds to give an approximate determination of this important law, for which we must refer to his work. Our own impression is that this law is almost solely concerned in the variation of the roughness of different combinations. We ourselves hear the roughness of beats up to very high numbers, and consider that up to high numbers beats of sensible intensity do not fail to be heard by reason of their number only. If this is the case the rapidity of beats must be of less importance in the theory of consonance than the law of dependance on intervals exhibited in the above quotation from Helmholtz.

To show the practical importance of this:—

(Pole, p. 213.) "Here we find the two fundamental notes themselves ($c' - e'$) beating at the rate of 64 per second. . . . This is, therefore, a less perfect combination than the fifth; but still the beats are quick, and the effect is not disagreeable."

This seems to us incorrect. If the 64 fundamental beats per second were present with any intensity to speak of, the combination would certainly be most dissonant. It is because the ear receives the two notes on different parts of the sensorium, and so gets them out of each other's way, that the beats do not exist in sensible intensity, and do not produce dissonance.

In the appendix on Beats, and an essay there referred to, Dr. Pole has developed doctrines which arise to some extent from the point of view above indicated. The statement made is substantially that the beats described by Robert Smith ("Harmonics," 1749), have a real existence, besides the various types of beats described by Helmholtz.

Smith's cycles are best seen if the sum of two harmonic curves be described by Donkins's harmonograph, or some such machine. Smith's doctrine consists of the statement that the cycles which appear in the resulting curves are the cause of the beats. (Of course Smith did not use pendulum-vibrations, but the use of these adapts the doctrine to our modern knowledge.)

Now in order that these cycles may be seen, it is necessary that one and the same scribing point should describe the sum of the two motions simultaneously. If the motion be analysed and its two components be described separately on the paper, the cycles fail to appear.

This is what must happen in the ear if the doctrines of Helmholtz are even approximately true. The two sounds (if beyond the minor third apart) fall more or less completely on different parts of the sensorium, and the conditions requisite in the first instance for the formation of Smith's cycles are not fulfilled. Whether, if the cycles existed, the beats could arise out of them in the way in which we hear them, is quite a different question, on which we will not now enter.

The great importance of this question has induced us to prolong our remarks on it. On these points every student should consult Helmholtz's work. But on the more purely musical questions Dr. Pole's book has its own value.

OUR BOOK SHELF

A Treatise on Chemistry. By H. E. Roscoe, F.R.S., and C. Schorlemmer, F.R.S., Professors of Chemistry in Owens College, Manchester. Volume II. Metals. Part II. (London: Macmillan and Co., 1879.)

THIS portion of Professors Roscoe and Schorlemmer's work treats of the metals of the iron, chromium, tin, antimony, and gold groups, also of spectrum analysis, the natural arrangement of the elementary bodies, and the condensation of the gases formerly called permanent. The treatment of these subjects is characterised by the same accuracy of description and clearness of explanation and arrangement that were so conspicuously displayed in the former parts, and the illustrations of metallurgical operations, &c., are well chosen and admirably executed, such, indeed, as are not to be found in any other English manual of chemistry. Amongst them may be especially noticed the figures of the plant for Weldon's method of regenerating manganese dioxide from chlorine residues, of the various forms of blast-furnace, of the Bessemer and Siemens-Martin processes for making steel, and of hydraulic gold-mining as practised in California. The best methods of detecting and estimating the several metals are carefully described, and interesting details are given relating to their history, some of which will, we think, be new to many readers.

Spectrum analysis, in which Prof. Roscoe is known to be a high authority, is well treated and illustrated, and attention is drawn to recent speculations, founded on spectroscopic observation, respecting the possible resolution of the bodies now regarded as elementary, into still simpler forms of matter. In the chapter on the Natural Arrangement of the Elements, a clear view is given of the remarkable relations between the properties of the elements and their atomic weights, first pointed out by Mr. Newlands, and further developed by Lothar-Meyer, and Mendelejeff; and the volume concludes with an account of the condensation of the gases formerly regarded as permanent, in which the ingenious forms of apparatus employed for the purpose by MM. Cailletet and Pictet are fully described and illustrated.

Altogether the two volumes of the work now published form a treatise on Inorganic Chemistry of which English science may well be proud; and the student who masters their contents will not fail to acquire a sound elementary knowledge of the subject. H. WATTS

Elementary Mechanics, including Hydrostatics and Pneumatics. By O. J. Lodge, D.Sc. Chambers's Elementary Science Manuals. (Edinburgh, 1879.)

THIS is one of the comparatively sound text-books which, since the publication of Thomson and Tait's work, have been every year more effectually thrusting aside the cumbrously artificial and often erroneous introductions to Physical Science which reigned almost unchallenged till about sixteen years ago. Dr. Lodge knows his subject well, and has evidently bestowed very careful thought upon it. Still we cannot unreservedly commend his book; and this for several reasons. First, he evidently proceeds under the idea that the subject can be made

easy to a beginner; that, in fact, there are no real difficulties which must be fairly faced by every student. We are surprised to find that this opinion can be held by any sound and successful teacher. Our own experience has always been dead against it. Dr. Lodge says of the elementary works of Thomson and Tait, Clerk-Maxwell, and Clifford, that they are "far too difficult for beginners." We do not think that his process of dilution makes the matter a whit less difficult. It has rather a tendency to conceal from the reader the place where the real difficulty lies, and a necessary difficulty *avoided* is certainly not *overcome*. Second, the avoidance of difficulties is managed by loose and sometimes even metaphysical language (see, for instance, pp. 83-5); evidently embodying some of the speculations in which the author has indulged while excogitating his work.

As an instance of loose writing take this (p. 16)

"5. The effects of force on matter are:
A. Change of motion, which is called *acceleration*.
B. Change of size or shape, which is called *strain* or deformation.

If only one force acts on a body, it must produce the effect A. If two or more forces act in different directions on a body, they must produce B, and they may produce A also." Now, at first sight, this looks well enough, and certainly Dr. Lodge knows the facts thoroughly. But how is *change of motion* called *acceleration?* Acceleration is correctly defined (p. 19) as *Rate* of change of *velocity*. But (p. 18) velocity is defined as "the rate of motion of a body." Put these extracts along with A above, and we find "change of that whose rate is called velocity is rate of change of velocity;" a very remarkable proposition, indeed one of high metaphysical interest. Again, if only one force act on a body, it *must* produce B unless the body be perfectly rigid. And two or more forces do *not* necessarily produce B, even on the most plastic body. Take the case of two different sets of parallel forces, for instance, each proportional to the mass of the element on which it acts.

In conclusion we may say that for the facts of elementary mechanics, for excellent examples of application of the formulæ, and such like matters, the student may use this work with profit:—but he ought to be warned that where the text appears most simple it is generally loose, often metaphysical, and here and there unintelligible.

Le conchiglie Pompeiane. Descritte dal Dott. Nicola Tiberi. 4to, 12 pp. (Napoli, 1879.)

THIS remarkable and well written memoir was published before the recent celebration at Pompeii of the eighteenth centenary of its destruction by a volcanic eruption of Vesuvius. It is the work of an excellent naturalist, who lives at Resina, close to the site of the ruined city, and who is especially conversant with the shells of the Mediterranean. The point of view to which he directs our attention is very different from that which has been taken by the geologist, antiquary, artist, or architect. He treats of the shells found in the ruins, and which had served for food, or been used by the Pompeians for ornament and other purposes. Indeed we know from Athenæus and other ancient authors that mollusca were then relished quite as much as they are at present by the inhabitants of Italy. I have been unable to discover in the loose and incorrect twaddle of the younger Pliny, who lost his life in the eruption, any mention of shells having been collected by his countrymen for the study of natural history. It is a pursuit or amusement of comparatively modern times. Dr. Tiberi gives a list of all the shells which he has noticed as Pompeian, belonging to no less than 44 species, with particulars of their relative abundance at Pompeii, as well as of their distribution and economy. Some were of eatable kinds, as the common oyster and mussel, *Pecten jacobæus*, *Venus chione*, *Tapes decussatus*, and several species of *Helix*. Others adorned fountains, as *Haliotis tuberculata*, *Murex trunculus*, and *M. brandaris*. The oriental pearl-shell (*Meleagrina margaritifera*) was represented only by a single valve. But the ladies of Pompeii seem to have attached considerable value to the *Cypræa* or Cowry, as amulets or charms to prevent sterility; and among these shells were some of species from the Red Sea and Persian Gulf. A single specimen of another exotic shell (*Conus textilis*) must have been kept for its great beauty as an object of curiosity. All the shells used in the ornamentation of fountains, five in the city and one in the suburbs, are of species which still are common in the Gulf of Naples; these shells are separately distinguished and named.

The memoir forms a short but interesting chapter of Roman history, and it tells us more than is generally known about the habits of the former masters of the world. J. GWYN JEFFREYS

Banka und Biliton. Von Dr. E. Reyer. (Vienna, 1879).

IN this pamphlet, originally published as an article in the *Oesterreichischen Zeitschrift für Berg- und Hüttenwesen*, the author has brought together a vast amount of useful information on these two important tin-yielding localities. At the present time, when the trade in this important but sparingly-distributed metal has been almost entirely diverted from its ancient centres in Cornwall and Saxony by the development of the sources of supply in the East Indies and Australia, the valuable details contained in this pamphlet cannot fail to be read with much interest. By far the largest and most reliable part of the information on these districts is inaccessible to most readers, from the fact of its being written in the Dutch language, and Dr. Reyer has done good service in bringing together so much material in a compendious and available form. The geological structure of the districts, the distribution of the ore in them, the methods of working, and the mineral statistics of the two areas, are very fully described, and the monograph concludes with an interesting sketch of the life of the Chinese immigrants who are engaged in working these tin ores in the Malay Archipelago.

J. W. J.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Greenwich Meteorological Observations

MR. BUCHAN (NATURE, vol. xx. p. 602) now admits that fundamental mean temperatures are to be found in Table 77. But his original unqualified remark (p. 526) was that mean temperatures for Greenwich "remain still to be calculated"; he even endeavoured to infer the mean annual temperature from the observations of the earth-thermometers, as though Table 77 (containing a value of this element with which no hitherto determined value for Greenwich can compete) had no existence. All this was likely to convey to an uninformed reader a very erroneous impression.

Table 52 contains simply a collection of the mean monthly results given in the twelve tables (38 to 49) referring to diurnal inequality, and as these numbers appeared to sufficiently well represent the varying temperatures of individual months, no account was taken of omitted days. But we can without difficulty determine their influence, usually small, in the months affected, and, in consequence of the now expressed want, shall probably take an opportunity of doing so. The question was of much greater importance as regards the fundamental values of Table 77, in forming which, as before mentioned, and as is

stated in the introduction to the volume, the influence of omitted days was duly taken into account, values for such days being adopted from the eye-observations (usually six daily) corrected for diurnal inequality by means of corrections derived from the discussion of the twenty years' photographs. Thus, among the twenty separate daily values on which each mean daily value in Table 77 depends, one or two may be derived from eye-observations in the way described.

The diurnal variation of temperature in the apartment in which the photographic barometer is placed is, on the average, less than one degree. WILLIAM ELLIS

Royal Observatory, Greenwich, October 27

Sun-Spots in Earnest

WITH reference to the fine group of sun-spots to which Prof. Piazzi Smyth draws attention in NATURE, vol. xx. p. 602, it may be interesting to mention that the incipient stage of the group in question is shown on two photographs of the sun taken at the Royal Observatory, Greenwich, on October 16 (two days before the date of Prof. Piazzi Smyth's observation). At that time the group consisted of three "veiled" spots and several very small specks hardly to be distinguished from the ordinary pores, together with small faculæ. No photographs were obtained on the next day, and on October 18 enormous changes had taken place, the "veiled" spots having developed into fine sun-spots, with nucleus and penumbra. Four photographs taken on this day show that changes were still taking place, and these continued throughout the remainder of the period of visibility of the group, viz., till October 21, when it passed off at the west limb. No trace of the group is to be found on two photographs taken on October 15, so that it would appear to have formed between October 15 and 16, and must have been quite in its infancy when first photographed on October 16, being then very nearly on the central meridian.

Several small spots have appeared on the sun lately, but they have been for the most part very short-lived. Thus a group of spots with faculæ, first seen on the east side of the sun on October 15, had completely disappeared on October 16. Another group consisting of six or seven small spots with faculæ, which appeared at the east limb on October 7, had completely closed up in the interval between October 10 and 15. On the whole the Greenwich photographs seem to support Prof. Piazzi Smyth's conclusion that the period of quiescence is now over, and that the solar activity is decidedly on the increase. W. H. M. CHRISTIE

Royal Observatory, Greenwich, October 25

THE Kew solar observations now are, unfortunately, limited to a daily inspection of the sun through a 3-inch telescope, and the drawing of a rough sketch of the spots on its surface, should any be visible, the object the Committee have in view being merely a continuation of the enumeration of the groups as they make their appearance, in the same manner as did Hofrath Schwabe.

I have referred to the sketches drawn on the 15th, 16th, 17th, and 18th instants, in order to see what records they afford of the outbreak of the group of spots mentioned by Prof. Piazzi Smyth in NATURE, vol. xx. p. 602, and find we noted on the 15th two small spots in the sun's northern hemisphere. These were not seen on the 16th, the disk being entered in the register as having "no spots," but at 10.30 A.M. on the 17th a group of small spots appeared to the south of the equator, just in the place occupied on the next day by the group of gigantic spots to which attention has been directed, allowance of course being made for the sun's rotation.

These observations show that the spots did not suddenly burst forth in their full grandeur, but that they broke through the sun's surface gradually, that is to say, the explosion, if such it was, extended over more than twenty-four hours.

In the examination of the Kew solar photograms from 1863 to 1872 now in progress here under the direction of Mr. De la Rue, we have found several instances of similar extensive changes in spots from day to day, not only in the eruption of large spots, but also in their closing up in an equally short space of time.

To give more recent instances, I find that a considerable group of spots was observed on June 28, of which we had no record on the 25th; and again, on July 11, some large spots were noted, whilst on the preceding day, July 10, "no spots" was entered in the register.

The magnetograph curves show a slight disturbance of the magnetic elements on the 16th and 17th, but during the 18th the needle simply recorded its ordinary daily range.

I trust that better-equipped observers will be able to give you more exact accounts of this interesting phenomenon. The sunshine recorder here indicated continuous sunshine on the 16th, occasional gleams on the 17th, and seven hours on the 18th, so the climate cannot be blamed for any shortcomings on the part of southern observers on this occasion. G. M. WHIPPLE

Kew Observatory, October 25

THE conclusion as to the increasing activity of the solar surface, drawn by the Astronomer-Royal of Scotland from his observations of a large solar spot on the 18th instant, is strongly confirmed by the present state of the south-east quarters of the sun's disk. Few prominences are now visible in the other portions of the limb, but on the 26th at 23° 10′ E. of the south point (direct image), the bright line C of the chromosphere extended to the height of 3′ 43″ from the limb, and this morning, the 28th, the greatest height was 1′ 17″ at 18° 46′ E. of S. On the 28th the remarkable prominences extended along the limb from—

18° 8′ E. of S. to 38° E. of S.,

and this morning they were traced from—

10° 51′ E. of S. to 20° 21′.

The ordinary level of the chromosphere does not extend above 5″ from the limb, but to-day it was rather over 6″.

Eight prisms of 60° were used in a Browning automatic spectroscope adapted to an 8-inch achromatic. S. J. PERRY

Stonyhurst Observatory, October 28

Wallace's "Australasia"

ALLOW me to thank the writer of the review in NATURE, vol. xx. p. 597, for some valuable criticisms of my book. It is quite refreshing after the common-place praises of most reviews to have one's errors pointed out and omissions noticed, and I hope to make use of such corrections in a forthcoming new edition. At the same time there are a few points on which I wish to say a word. In the first place the book is not a scientific work, but one of a series intended, as expressly stated, "for general reading." This is, of course, no excuse for errors, but it is a sufficient reason for giving *general* rather than detailed descriptions of weapons, canoes, &c., and for occasionally stating roughly the *size* of an article even when it varies greatly, in order to give definite ideas to readers who may be complete strangers to the whole subject.

I quite agree with my reviewer, that too much is included to be properly treated in one volume, but that was a matter dependent on the arrangement of the series, over which I had no control; and as I had in the earlier portion of the work overrun the space allotted me, I was obliged to restrict my notices of many parts of Polynesia, which is no doubt the most imperfect portion of the volume. It is here that the original work is most utilised, and it will be found that most of the passages criticised (including that in which I am charged with "becoming quite poetical") are Hellwald's. Of course, I should have corrected all his small inaccuracies, but it was almost impossible to do so without rewriting his work altogether. No doubt a very interesting volume could be written on Polynesia alone by the aid of the German authorities referred to by the reviewer; but when I state that the time allowed me for the composition of the entire work was six months, and that I actually completed it in eight, it will be seen that I was compelled to limit myself in the study of authorities as well as in the space I could devote to particular islands.

I think my reviewer forgets the character of the book as essentially geographical, when he objects to my treating New Zealand apart from Polynesia; hence I cannot admit the soundness of his criticism on the comparison of the characters of the Fijians and Polynesians, a comparison which, if I remember rightly, is that of an author who knew them both thoroughly—the Rev. G. Turner. I must also demur to the implication that land can never have extended where there is now a sea 2,000 fathoms deep. I suggest (p. 564) an extension of New Zealand as far as the Kermadec Islands as having possibly occurred "at some remote epoch," and I certainly fail to see its impossibility; yet this is what is suggested by my reviewer's remark, that unfortunately there is a depth of 2,000 fathoms between

them, and that such an extension "cannot therefore have existed." Moreover, the beautiful map of ocean depths with which the volume is illustrated shows a somewhat less depth than 2,000 fathoms on a slightly curved line between the islands, and I believe about the same depth exists between Madagascar and Africa, which have certainly at one time been joined.

There are some other matters touched upon on which I still venture to differ from my reviewer, especially as to the marvellous character of the Easter Island and other remains, and as to the value of the substitution of more for less liberal sectarian teaching in the Sandwich Islands; but on these points I have quoted authorities of considerable weight, and I leave my readers to form their own opinion. As to all matters of fact, I gladly accept correction from one who evidently writes with the advantage of a personal acquaintance with most of the countries referred to in his article. ALFRED R. WALLACE

Climatal Effects of Eccentricity

I AM grateful to Dr. Croll for noticing my letter. But I continue to think that if what seems to me to be the fundamental proposition of his theory, and which I quoted at the beginning of my former letter, be correct, and if the manner in which he and his reviewer have applied it be likewise correct, then we ought to find those differences in the *air* temperatures which my equations indicate. I say air-temperatures, because in Dr. Croll's theory changes of climate are referred to the varying distance of the sun, and climate depends on the temperature of the air.

The heating effect of the sun, other things being equal, has been hitherto assumed to be proportional to the excess of the temperature of the place above the temperature of space. A remarkable result which Pouillet had arrived at, and of which I was not aware when I wrote, shows that this method is incorrect. And I believe that what follows will to some extent afford a reply to the question which I have propounded, and at the same time have a proportionate bearing on Dr. Croll's theory. I quote Pouillet's words from the translation in Taylor's "Scientific Memoirs," vol. iv. p. 83.

"The total quantity of heat which space transmits in the course of a year to the earth and to the atmosphere . . . . would be capable of melting upon our globe a stratum of ice of 26 metres thickness. We have seen that the quantity of solar heat is expressed by a stratum of ice of 31 metres. Thus, together, the earth receives a quantity of heat represented by a stratum of ice of 57 metres; and the heat of space concurs in this for a quantity which is five-sixths of the solar heat. Between the tropics the heat of space is only two-thirds of the solar heat; for the latter is there represented by a stratum of ice of 39 metres."

These surprising results arise from the unequal absorption exercised by the atmosphere upon the heat rays proceeding from the stars and from the earth respectively.

It appears then, that, in applying Dr. Croll's proposition, we ought not to use the value of the temperature of space in forming our proportion, but we ought to use the temperature which the surface of the ground would assume were the sun extinguished. This Pouillet puts at $-89°$, or $-128°$ F. The substitution of 128 for S., instead of 239, reduces my calculated difference between the January and July temperatures at the equator to 11° F., *i.e.*, by about one-half.

If we make the same correction in the case, the high eccentricity at aphelion, for which the *Quarterly Reviewer* has calculated the January temperature of England, and found it 3° F. (I make it even lower), the new temperature comes out 17° F., which can hardly be thought low enough to cause any extreme difference from the present climate. O. FISHER

October 25

THE statement quoted by Mr. Fisher from Dr. Croll (NATURE, vol. xx. p. 577) that "the temperature of a place, other things being equal, is proportional to the heat received from the sun," is based on the assumption of Newton's law of cooling, viz., that the rate of cooling of a body is proportional to the excess of its temperature above that of the surrounding medium. This is approximately true only when the excess is small. When the excess becomes large the rate of cooling augments much more than in proportion. The amount of heat which must be supplied to a body in order to maintain it above the temperature of the surrounding medium is proportional to what would be its rate of cooling. Hence this amount increases as the excess of temperature increases—proportionally while the excess remains small, but much more than proportionally when it becomes large. Conversely, the temperature increases more slowly than the amount of heat supplied, and any variation in the supply will affect the temperature produced in a degree which is less for a large excess than for a small one, and, therefore, less than Newton's rule would give. The excess of the earth's mean temperature above that of space is large, and consequently calculations of changes based on Newton's rule must be in excess of the truth.

The formula obtained by MM. Dulong and Petit (Stewart on "Heat," Art. 235) from the rate of cooling of a thermometer-bulb *in vacuo* makes the necessary supply of heat proportional to $(1{\cdot}0077^t - 1)$, where t is the excess of temperature in Centigrade degrees. If we apply this to the case of the earth, and take 80° F. as temperature at the equator when the earth is at its mean distance from the sun, then the resulting temperatures at its greatest and least distances with our present eccentricity, are given as about 74° and 85° respectively. The fluctuation, which Mr. Fisher makes 21°, is reduced to about 11°. The fall in temperature which would follow a stoppage of the Gulf Stream is made by Newton's rule 59° ("Climate and Time," p. 36): the more accurate formula reduces this to about 37°. Dr. Croll suggests that the temperature of space may be lower than is usually assumed (p. 37). If it be taken as absolute zero ($-459°$ F.) the fall would not even then come out much greater than 45° F.

Several of Dr. Croll's tables should be similarly modified; at the same time it would be scarcely correct to say that these changes "touch Dr. Croll's theory somewhat closely." They do not invalidate the general contention, that a diminution of the Gulf Stream must diminish the mean temperature of northern regions to a very serious degree. E. HILL

St. John's College, Cambridge, October 25

The Weather and the Sun

PROF. PIAZZI SMYTH in his communication to NATURE, vol. xx. p. 431, evidently infers that changes in the condition of the sun must needs affect every part of the earth in the same way, whereas we have many meteorological analogies, which favour the notion that totally *opposite* effects may arise in different parts of the earth from the action of the *same* primary causes. For example, it is generally assumed that the same tropical heat which gives the primary impulse to the desiccating north-east trade wind of sub-tropical latitudes, furnishes the energy which exhibits itself in the almost constant precipitation under the equator. Any variation in the degree of this heat, should consequently affect localities situated in the region of the trades, and the equatorial calm-belt, in a diametrically opposite manner. Moreover, the notion that the British and Indian rain falls vary together now is altogether inconsistent with the well-known want of similarity between them, both as regards seasonal distribution and annual quantity in the past. It is also remarkable that while the present deluge both here and in India is traced to the sun's "*recovering* his forces and beginning already to shine after his recent languid spotless years with increased radiation on the great oceans of the south," the rainfall of England between latitudes 50° and 55° N. reached a decided maximum in 1877, the year when the sun was, to adopt the favourite metaphor, affected with the most extreme languor, and has been very high all through the period of unusually marked spot minimum, from which we are but just emerging.

The following figures from Mr. Glaisher's reports will illustrate what I have just said.

Great Britain, Lat. 50°—55° N.

Years.	Rainfall in inches.
1875	34·04
1876	34·60
1877	38·55
1878	32·61

More valuable results will generally accrue to science if, instead of founding vague hypotheses on a fancied likeness between isolated weather conditions, at places where the prime meteorological factors act in a totally dissimilar manner; induction is made from results which are derived from trustworthy data, and anticipated by a knowledge of admitted physical principles. As an example of this latter kind, allow me to conclude this letter by exhibiting

to your readers a recently discovered regular secular period in one of the meteorological elements of Calcutta; a period too, (though this is at present a matter of secondary importance) which decidedly favours the reverse hypothesis to that entertained by Prof. Smyth regarding the variation of solar energy. The following figures have been worked out, and communicated to me, by Prof. S. A. Hill of Allahabad, and he has I believe given his conclusions from them and similar results, in a recent number of the Austrian *Zeitschrift für Meteorologie*, which, however, I have not as yet seen.

The table which follows, shows the annual range of mean monthly barometric pressure at Calcutta, from 1840 to 1878 inclusive, bloxamed in a series of eleven years, the average length of a sun-spot cycle, beginning with the year of sun-spot minimum.

Calcutta.

Years of cycle.		Annual range of mean monthly pressure in decimals of an inch.
11	Years of minimum sun-spot	·530
1		·549
2		·538
3	...	·510
4	...	·499
5	Years of maximum sun-spot	·502
6		·502
7	...	·500
8	...	·506
9	...	·512
10	...	·514
11	...	·530

The figures for Roorkee, from 1864 up to the present time, give a similar result. So far then as we have gone at present in India, we find years of few sun-spots characterised by higher temperatures, greater wind-velocity, and greater range of barometric pressure than those of many spots. The terrestrial effects of a "languid" sun are therefore strikingly like those of an unusually *hot* sun.

E. DOUGLAS ARCHIBALD

Grosvenor House, Tunbridge Wells, October 18

Colour-Blindness

WHILE the subject of colour-blindness is before your readers, the present seems a favourable opportunity for calling attention to a method of experimenting which I used some years ago[1] for testing normal vision, and which seems, if applied to colour-blind eyes, likely to be capable of telling us something of the nature of that peculiar form of colour sensation.

When I made my experiments on normal eyes I intended extending the investigation to colour-blind eyes, but most unfortunately I was quite unable to find a true case of colour-blindness. All the cases reported to me proved, on examination, not to be produced by colour-blind eyes at all, but to be the result of want of observation and knowledge, as they all could distinguish between different colours, when placed alongside each other, and could also arrange the different colours, though when shown colours separately they made dreadful mistakes in naming them.

The method adopted in my experiments was as follows:—A prismatic spectrum was produced by passing a beam of light through a slit, a lens, and a bisulphide of carbon prism, in the usual way. The spectrum was thrown on a large number of rectangular reflectors, placed close to each other, and all capable of being moved so as to throw the light reflected from them to any point on a screen in front. With this apparatus we have the means of testing what colours can be produced by mixing others, and what colours cannot be so produced—by throwing the light reflected by one of the reflectors on the screen and trying if it is possible to match it by combinations of rays from other parts of the spectrum. It is found that for the normal eye the same sensation which is produced by the yellow part of the spectrum can be produced by mixtures of rays from the red and green parts, and also by rays from parts lying between these colours and yellow. And that the sensation which we call blue, can be produced by the blue part of the spectrum or by mixing rays from each side of the blue, that is by mixtures of violet and green. The yellow and blue are, however, the only two parts of the spectrum, the sensation of which can be imitated by combining rays from other parts of the spectrum. We cannot, for instance, produce green by any mixtures of rays from other parts of the spectrum. The red and the violet sensations are also incapable of being produced by mixtures.

[1] *Proceedings* of the Royal Scottish Society of Arts, 1871-2.

These results are, to a certain extent, a proof of the threefold nature of our colour sensations. And they also show us that it is a mistake to talk of colours as simple and compound, as all the colours we find in nature are compounded of rays of many different rates of vibration. The difference between different colours is, those of one rate of vibration, say those of the D-line, even though absolutely pure, are capable of exciting a compound sensation, namely, the red and green, while mixtures of rays from each side of the line B, are only capable of giving rise to a simple sensation—namely, the red.

Supposing this three-sensation theory to be true, then there are certain conceivable variations of it which would give rise to colour-blindness. The blindness, for instance, might be produced by two of the three sensations being very similar. This does not seem improbable when we consider that, to any two persons, with normal eyes, the different colours will not necessarily appear equally different, and that, in the same normal eye, the different simple sensations are not separated by equal differences from each other. That is, supposing our sensations of the three primary colours to be represented by the three angles of a triangle, then the triangles, if drawn to the same scale, would be of different sizes for the eyes of different persons, and for almost all eyes the triangles would not be equilateral. The side between the green and the violet would be shorter than the other two, because the sensation of green is more similar to the sensation of violet, than green is to red or red is to violet. Or we might conceive the colour-blindness to be produced by the different sensations being irregularly, or by being too widely, distributed over the spectrum. If, for instance, the green sensation extended into the red part of the spectrum and the red sensation into the green part, that is, if the same rays excited both sensations in the same proportion, not only in certain parts, but throughout their entire range, then an eye, so constructed, would be incapable of distinguishing red from green. Another way in which colour-blindness might result, is by an absence of one of the three sensations.

It is impossible, without experimenting on colour-blind eyes, to say whether any of these, or some other, is the true cause of colour-blindness, and it is very desirable that some one, accustomed to make colour observations, would test colour-blind eyes in the way suggested; it would settle at once, for the particular eyes experimented on, whether they are badly defined trichroic eyes or are dichroic. If the eyes are dichroic, then, clearly, there will be only one part of the spectrum, the sensation of which can be produced by mixtures of rays from other parts, and not two as in trichroic vision.

Besides the apparatus described many others, more accurate, might be constructed, but the great advantage of this arrangement is, that it is suited for testing eyes not accustomed to make accurate observations or to be trammelled with elaborate apparatus. If Prof. Pole was to undertake the investigation, he could easily devise some simple apparatus to suit the experiments which, in his hands, would probably give some valuable results.

Darroch, Falkirk, October 7

JOHN AITKEN

Subject-Indexes to the Royal Society Catalogue of Scientific Papers

As you have opened your columns to Mr. Garnett's valuable paper on "Subject-Indexes to Transactions of Learned Societies," you will perhaps allow me to make a suggestion in regard to the proposal contained in it. The initial objection to Mr. Garnett's scheme appears to me to be that the work he suggests will really be as large as the original catalogue, and, in fact, the same work in a new order. Even were it possible to get the money (probably little short of 10,000*l.*), the question would naturally arise whether or no the result was likely to be worth this great outlay. Moreover, the plan proposed by Mr. Garnett would not meet the great difficulty of compilation, which consists in the getting together of papers treating of identical subjects, but written with various titles by different persons. This would make it necessary to employ experts in each subject, and also a general practical editor for the whole, under whose eye all entries must pass. I cannot help thinking, therefore, with Mr. J. B. Bailey (p. 580), that the titles of the papers would have to be generally ignored.

If the index were made as indexes to catalogues are usually compiled, it might be got into at least a third of the space of the

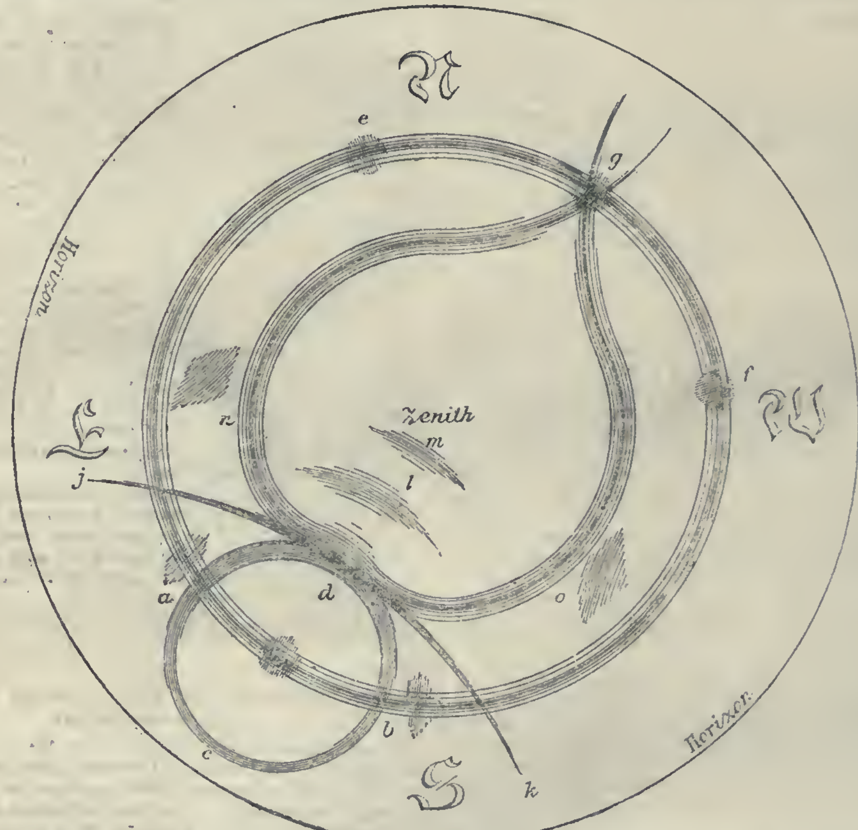
original book, perhaps into a sixth. As to the need of such an index there cannot be two opinions. If, however, a fuller classified catalogue, such as is proposed by Mr. Garnett, be thought necessary, would it not be better to make it in the form of a series of indexes of separate subjects? The day for great encyclopædic works is nearly past, and as the astronomer cares little for the papers of the zoologist, and would find them only in his way, so both the zoologist and the astronomer would wish to have his own subject in a distinct volume.

This leads me to the chief point of this letter, which is to draw attention to the work that is already being done. I have received a letter from Prof. Holden, of the United States Naval Observatory, in which he announces to me, as Secretary of the Index Society, his intention of making an index to all the entries referring to astronomy in the Catalogue of Scientific Papers, and also informs me that Prof. Abbe, of the United States Signal Service and Weather Bureau, has a complete card catalogue of the meteorological entries in the Royal Society Catalogue. Probably other workers have done the same for other subjects. This is, I think, the best use to make of the Catalogue of Scientific Papers, which is of immense value, in the first place as a catalogue of authors, and secondly, as a collection of anthentic documents from which a series of subject-indexes may be drawn.

Society of Arts, October 28 HENRY B. WHEATLEY

Solar Halo

I INCLOSE a sketch of a remarkable solar halo and parhelia which I observed here on the 22nd ult. As I happened to have facilities at hand, I was enabled to take the dimensions and position of the various features of the phenomenon with sufficient accuracy. These appearances were first seen by me at 9.30 A.M., and continued nearly constant in brilliancy till about 10 A.M., when they gradually faded, and at 10.30 hardly anything was visible except the outer ring, *abefg*, which continued till 1 P.M. At 9.45 the inclosed sketch was made and the measurements taken. The sun had then an altitude of about 30°, and was very misty and indistinct. It was surrounded by an ordinary solar halo of about 45° diameter; and through the sun passed another perfectly unbroken circle whose centre was exactly at the zenith. This circle had no colour and was similar in character to the ordinary concentric solar halo; its angular diameter was 120°; concentric with this was another circle of 78° diameter. This inner circle was not quite perfect at the point where the circle, *abcd*, touched it; it was slightly distorted, and through the same point (*d*) passed a portion of another circle of larger radius, *jk*. The junction of these three circles formed a beautiful spectrum, and was the most brilliant



part of the whole phenomenon. The inner circle was also imperfect on the side opposite the sun, when it branched off in two opposite curved tails, which, crossing the outer circle at the same spot, *g*, formed a mock sun. Two other mock suns were to be seen at *e* and *f*, 50° to each side of *g*. These three mock suns were all colourless, but at *a* and *b*, not on the concentric halo, but about 2° outside it, were two beautifully coloured mock suns, each being a perfect spectrum.

Finally, two portions of coloured circles were seen at *l* and *m*, with the concave side towards the sun, and two others at *n* and *o*, with their convex sides towards the sun, but in every case (both of circles and mock suns, *a* and *b*) the red colour was nearest the sun and the blue farthest from it.

I may mention, to give an idea of the brilliancy of the phenomenon, that many persons mistook one or other of the coloured bands for rainbows, and in one case one of the mock suns was supposed to be the sun itself (the sun happening to be hid from the observer by some adjacent buildings).

Dublin, October 11 HOWARD GRUBB

Karl Friedrich Mohr

IN your notice on the late Karl Friedrich Mohr there is no mention made of one of his most remarkable works, "Die Geschichte der Erde," the first edition of which appeared in 1866. In it he takes up what he considers entirely new ground

and certain of his chapters are in the highest degree interesting. His chapter on the origin of coal is perhaps more interesting than any other, and is full of suggestive reasoning. I have not seen the work cited in any of our treatises on geology, and yet the opinions of such an eminent chemist must have some weight in the treatment of problems wherein chemistry alone can furnish a satisfactory solution. J. P. O'REILLY

Dublin, October 22

Suicide of Scorpions

THE self-destruction of the scorpion when hard-pressed is unquestionable. I have on several occasions invited sceptics to witness the tragedy (!) in this part of Europe.

The scorpion we frequently meet with in and about "Sierra Morena" under stones and in crevices, is a large light-brown species often more than *two* inches from head to sting.

Having procured one I have placed it in a circle of glowing charcoal embers a foot or so in diameter; after vain attempts to get away it raises its tail over its back, pierces its head with its sting and dies, precisely in the way described by Dr. Thomson (NATURE, vol. xx. p. 577). F. GILLMAN

Provincia Jaen, Linares, Spain, October 20

Superficial Earthquakes

CAN any correspondent oblige me with an explanation of the following facts? The earthquake which took place at Virginia City some time ago was not felt by the workmen in the mines. Some years ago a much more violent earthquake shook the town, breaking chimneys, overthrowing houses, and so on. But it was hardly to be noticed in the mines; indeed, not at all in the deeper shafts. E. BURKE, Jun.

October 16

Coloured Lightning

ABOUT 4 P.M. to-day we had a pretty severe thunderstorm, accompanied by heavy rain, and the entire heavens were overcast by one unbroken cloud; three or four flashes of lightning were of a distinct blue colour, and then followed a flash of beautiful rose colour, succeeded by more flashes of blue lightning. Will some of your correspondents explain the cause of change of colour? and oblige A CONSTANT READER

Welland, Ontario, Canada, September 28

"MEMORIA."—The correspondent who signs herself thus must send her name if she wishes her letter to be inserted.

OUR ASTRONOMICAL COLUMN

THE SATELLITES MIMAS AND HYPERION.—The following are approximate times of the greatest western elongations of *Mimas* during the first week in November:—

	h. m.		h. m.
Nov. 1 ...	14 24 G.M.T.	Nov. 4 ...	10 15 G.M.T.
" 2 ...	13 1 "	" 5 ...	8 52 "
" 3 ...	11 38 "	" 6 ...	7 29 "

Observations of *Hyperion* during the present opposition are required before a reliable ephemeris of this satellite can be furnished. The true motion of the peri-saturnium is yet doubtful, unless Prof. Asaph Hall has been able to decide upon it from later observations than have been published. As we have stated before, Mr. Marth some years since conjectured that it might be as great as $+75°$ annually, and this rate of motion accords with Bond's determination of the place of the peri-saturnium in 1848 and Hall's results from Mr. Lassell's observations in 1852, and his own in 1875. So far as we know the Washington measures of 1878 are not yet published; probably they may throw more light upon the subject.

ANUARIO DEL OBSERVATORIO DE MADRID.—The seventeenth volume of this compilation (for 1879) reaches us late in the year. It is one of those useful compendiums of which the *Annuaire du Bureau des Longitudes* is probably the oldest, and may be taken as the type. Astronomical phenomena and details occupy a considerable space, and the volume is therefore fitly noticed in this column, but there is a great amount of miscellaneous information, geographical, meteorological, physical, and otherwise, which will recommend it to a larger class of readers. We remark some few points to which exception might be taken on the score of want of accuracy or completeness; thus the independent discovery of *Hyperion* by Mr. Lassell is not recorded, and the number of Uranian satellites is set down as eight, though four are queried with good reason. The discovery of Tuttle's comet is dated in 1858, no mention being made of its appearance in 1790. It is doubtless through a misprint that Encke's comet is stated to have appeared in 1695. Many of the miscellaneous tables are very full, as, for example, those of the altitudes of mountains in all parts of the world, the length of rivers, and the meteorological conditions in various parts of the peninsula, and as regards Spanish science, &c., the volume is no doubt to be considered authoritative. There are many who have occasion to consult works of this kind, who may like to have their attention directed to the present publication of the Royal Observatory at Madrid.

A NEW PRIVATE OBSERVATORY.—Observatories erected, equipped, and maintained in activity by private individuals are numerous in this country, and, as will appear from Prof. Holden's recent report, there are many of them in the United States; but the number of known observatories of this class upon the continent of Europe is not great, and the more interest therefore attaches to the addition of a new one to the list. Dr. Jedrzejewicz gives some account of an observatory he has constructed at Plónsk, about 37 miles from Warsaw, or in lat. 52° 37′ 39″, and long. 20° 30′ 59″ E. of Greenwich. The principal instrument is an equatorially-mounted refractor by Steinheil, of 6·4 inches aperture, to which are attached filar and other micrometers, and a spectroscope. Acting upon the advice of Dr. Vogel of Potsdam, Dr. Jedrzejewicz has the intention of devoting his time mainly to the measurement of double-stars, selecting such objects as are well within the power of his telescope; indeed, he has already made a considerable advance in this direction, having secured 860 complete observations of 170 double or compound stars, the result of some 8,500 separate measures, and with the view to enable astronomers to judge of the amount of confidence to be placed in the observations that may be published from Plónsk, he has given a comparison of his measures of a number of stars, which do not exhibit change, with those of Struve and others, and the comparison will tend to induce reliance upon his work. One remark we may make which bears generally upon the selection of objects for measurement with such an aperture as Dr. Jedrzejewicz possesses: it appears to have been too much the custom with the generality of observers who devote themselves to double-star astronomy, to accumulate a large number of measures of well-known, we may almost say, historical binaries, to the neglect of other objects, equally within the scope of their instruments, and equally deserving of attention. A carefully-considered list of stars is an essential in the actual state of this branch of the science, if the labours of the observer are to possess their utmost attainable value, in the future. The numerous discoveries of Mr. Burnham in particular confirm us in this view; his various lists exhibit many stars which it is highly desirable to keep under observation, and which do not yield in point of interest to other better-known binaries.

GEOGRAPHICAL NOTES

THE Japan papers report, with expressions of great regret, the loss, of which we have already had news by telegraph, of the *A. E. Nordenskjöld*, the little vessel

which M. Sibiriakof fitted out for the relief of the *Vega*. The vessel left Yokohama on August 1, and was lost on August 5, near Nemora, at the north-eastern point of the island of Yesso. The *A. E. Nordenskjöld* was commanded by Capt. Sengstake, an Arctic explorer of repute, who, when called to this duty, had arranged to accompany Dr. Otto Finsch in his expedition to the Pacific. The crew consisted of picked Arctic sailors, and there were also on board M. Gregorief, representing the Russian Geographical Society, and Herr Dankelmann, of Leipsic, the delegate of the Bremen Society. All on board were saved and were stated to be returning to Yokohama.

DR. OSCAR LENZ will shortly start on a tour to Marocco by order of the German African Society.

Les Missions Catholiques has published, in its last two numbers, some notes on Assam and the neighbouring countries, which have been furnished by a Roman Catholic missionary. By a singular coincidence the second instalment, containing an account of the Naga tribes, appeared just at the time when news arrived of Mr. Damant's murder in the Naga Hills.

THE new *Bulletin* of the Société de Géographie Commerciale, of Bordeaux, contains a paper of some interest, by M. G. Revoil, entitled "Le Pays des Çomalis-Medjourtines," which is accompanied by an outline map of that portion of Africa.

THE members of the Geographical Society of Algiers held their first meeting in the Hotel de Ville of that city on October 22, to elect their officers.

THE just-published *Bulletin* (for August) of the Paris Geographical Society, contains the itinerary of the Abbé Desgodins, of his journey from Pa-tang to Ta-tsien-len and back in 1877, and an account of the journeys of Père Duparquet in South Africa, by the Abbé Durand. There are some interesting letters between Dr. Rohlfs, Dr. Stecker, M. Duveyrier, and M. Marié Davy, concerning observations made in North Africa by Dr. Stecker, on electrical and other natural phenomena.

MR. STANFORD has just published a large scale map of Japan, which forms probably the best map of the country now in existence. It has been compiled by Mr. Knipping, whose official position in Japan has given him exceptional advantages for obtaining the necessary material. He has used the native Japanese surveys, which we believe are wonderfully accurate, data collected during his own extensive journeys in the country, travellers' narratives, and consular reports. The map is on the scale of seventeen miles to an inch, and is creditable to author and publisher, and certain to prove useful to all who have dealings with the country.

MR. EDWARD F. SANDEMAN will shortly publish, through Messrs. Griffin and Farran, an account of his travels in South Africa, under the title of "Ten Months in an Ox Waggon; Reminiscences of Boer Life." A special feature of the book will be the description of the home life of the Boers and their chief characteristics, and it will contain half-a-dozen chapters of shooting experiences in the country to the far east of the Transvaal, with accounts of the various big game of that region. A visit to the gold fields is also described, and some account will be given of the life of the miners. The volume will contain a map of the country.

KEW GARDENS

IT is highly desirable that the public should be fully acquainted with the real objects of the establishment of which we have the annual report[1] before us, as a very imperfect impression on the subject is prevalent. That object is not simply to collect as many forms of vegetation as admit of cultivation, with a view to facilitate the studies of botanists, whether young or old, much less to make mere collections of plants without any ulterior view; but while its unequalled herbarium and diligent staff are enabled to promote botany as a science, it has in view the rational recreation of multitudes and the accompanying improvement in taste, from the familiarity with exquisite forms and combination of colouring, aided by the attendant prevalence of order in each department; while in an economic point of view there are facilities for the investigation of diseases which affect our commerce or manufactures, unequalled facilities of diffusing through our colonies productions which may prove of vast importance to their interests, inquirers at home being able at once, through the museum and its curator, to become acquainted with matters in which their factories are more or less concerned, and thus to obtain information which in many cases has proved the source of national advantage. At the same time there are great opportunities for young cultivators gaining such a knowledge of the structure and intimate nature of plants as will not only be useful to themselves and their employers, but which has a tendency to improve by example the numerous tribe of gardeners who are too often deficient in the very knowledge which is of the utmost importance to successful cultivation. The interchange of plants and seeds also is carried on to a great extent at Kew, which is now the acknowledged ultimate medium for all communications from abroad with reference to what may be called industrial plants. The mass of correspondence which is carried on in this very useful department is almost overwhelming. Amongst other things, india-rubber plants, coffee, and quinine-producing barks, have received peculiar attention, respecting which interesting details will be found in the report. The cinchona plantations, not less than those of coffee, are every day of increasing importance, much of which is due to our national establishment at Kew. Not only have pains been taken to introduce the most improved forms of the coffee-plant, but the disease which is ravaging the coffee-plantations in Ceylon has been diligently studied by Mr. Abbay, whose observations were commenced in Ceylon in company with Mr. Thwaites. The first step to combating with diseases is doubtless an efficient knowlege of their nature, and it appears that the observations of these gentlemen and Mr. Morris have been attended with success in the application of proper remedies. Full figures are given in the report of the structure and nature of the coffee mildew by Mr. Abbay. This is not the only good work which has been done at the new laboratory during the past year, where the writer of the present notice has more than once profited by the facilities which it affords for observation.

It is not to be expected that the introduction of useful plants will be equally successful everywhere. Much depends on the intelligence and care of the recipients, even when there is no inaptability of climate. We anticipate in future reports that the diffusion of other matters less generally known will be recorded as at once successful and important. There is, perhaps, no set of plants of more importance than those which produce india-rubber. Attention was drawn years ago to the wasteful destruction of native plants and the necessity of greater care being taken with the forests in which these trees abound, and a committee was appointed for the furtherance of this object. The trees which produce this valuable substance are various, and belong to very different natural orders, and the extension of different sources of production, in consonance with different varieties of climate, has been a matter of constant anxiety at Kew. Here, again, a perusal of the report before us will be highly instructive.

Besides the matters above mentioned, at the close of the report many suggestions of sources of possible utility are given, which will be read with much interest, amongst which we may mention the Rain-tree of Peru, the South

[1] "Report of the Progress and Condition of the Royal Gardens at Kew during the Year 1878."

African Bamboo, the Sugar-Cane Disease, Substitutes for Vegetable Ivory, and Paper Materials.

As regards the plants under cultivation, it should be stated that great pains are taken to name them conspicuously and correctly, a matter of extreme importance to students, and one which every day engages the unwearied attention of the staff at the Herbarium. Without almost unlimited means the collection could scarcely be much extended. The admission, however, of Mr. Peacock's unequalled collection of succulent plants for a limited but sufficiently extended period should not be passed without notice. The proposal was a happy one, and the acceptance much to the credit of the authorities. The groups of hardy economic plants and of those of a similar character which require a higher temperature than our country can offer are of especial interest to the student. The plants of peculiar botanical importance which have flowered during the past year are duly recorded, while an especial report, accompanied by a figure, is devoted to a new tropical fodder-grass which grew and flowered under store treatment. At Singapore, Adelaide, and elsewhere the hopes conceived of it are very great, and seeds of it have been widely distributed from Kew. Nor are matters of cognate interest at home neglected. A notice is given of that form of the prickly comfrey which is likely to be a valuable fodder plant in Great Britain and Ireland. It seems to be a hybrid between *Symphytum officinale* and *S. asperrimum*; we have seen it lately in great perfection and in full usage, where it is greedily consumed by cattle, which thrive upon it immensely, while they will not touch the common comfrey.

The ravages of insects amongst plants are of no less interest than those which are produced by fungi. A very small bug, for example, is highly detrimental to the tea plantations in India, and Mr. McLachlan has given a great deal of valuable information on such subjects, information of such importance that the want is suggested of a consulting entomologist, at the disposal of the different Government offices, who should receive a retaining fee in return for investigating and reporting upon the various questions respecting which the residents in our various British dependencies apply for information.

At the commencement of the report there is a notice of the condition of the tropical fern house as regards the decay of the rafters, which the late storm has too sadly confirmed, and it is in consequence suggested that some hard wood like teak or blue gum should be substituted. The suggestion is one of great importance to all who are interested in the sustentation of their stoves and conservatories. Foreign deal is often dangerous. Every one who has watched the progress of decay in imported wood as used in railway construction, must have seen how soon they become infested with such fungi as *Lentinus lepideus*, *Trametes pini*, and *Lenzites sepiaria*, of course, from spawn contained in the wood. But home-grown wood is no less subject to decay from fungi. Where oak is grown from old stools, the wood is apt to have a tint, which, to persons well skilled in such matters is known as foxy. Such wood would at once be rejected in our naval yards, but we have seen a case in which it was used in the construction of a range of hothouses, where the whole in a few years was destroyed by *Dædalea quercina*; and deal, whether of home or foreign growth, is soon infested with *Polyporus medulla panis*, which is, we believe, a condition of one of our commonest fungi. It is not always possible to say whether any mycelium is present in wood; it is better, therefore, as Sir Joseph Hooker suggests, to use some material less liable to decay.

It remains only to notice the acquisitions to the herbarium during the past year. One of the most important is a collection of fungi containing more than 10,000 species, a great portion of which are typical. That of Mr. Dazell is important from its containing type specimens of the Bombay flora. Messrs. Cosson, Miers, and Casimir De Candolle have sent collections of greater or less magnitude and value, while the list of contributors either in specimens or drawings occupies more than three columns. The botanical publications prepared in connection with the work of the herbarium have been of an importance equal to that of former years, while the third volume of Hooker and Bentham's Genera now in the course of printing, is the result in great measure of last year's studies, which have never wavered.

M. J. BERKELEY

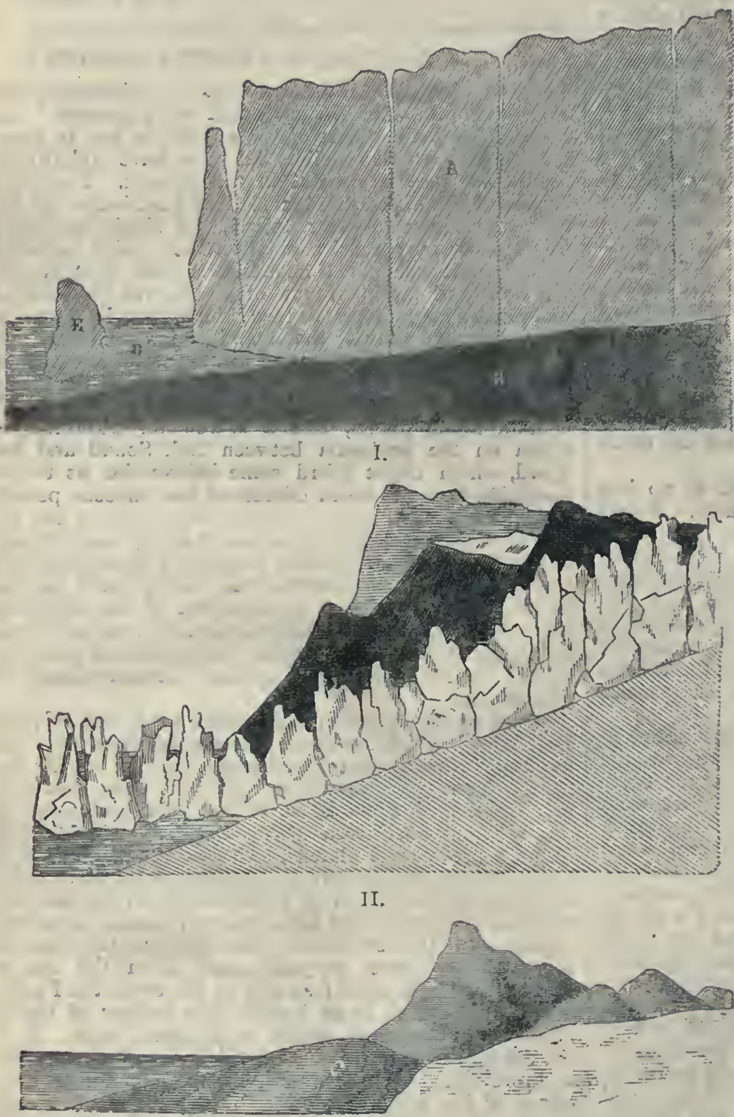
NORDENSKJÖLD'S ARCTIC VOYAGES[1]

NORDENSKJÖLD'S next visit to Spitzbergen was made in 1868, in a "small weak steamer" the *Sofia*. The main object of the expedition was to penetrate as far north as possible, but as we have said already it was not very successful in this respect. The other objects of the expedition included an examination of the flora and fauna of Bear Island, the single remaining fragment of an extensive polar territory which probably at one time connected Scandinavia with Spitzbergen, the flora and marine fauna of which was still almost unknown, though fitted to throw important light on the animal life not only of the Scandinavian peninsula, but also of the northern shores of Britain which are washed by the Gulf Stream; a careful examination of the strata on Bear Island and at Ice Fjord and King's Bay which contain fossil plants, and a search for post-miocene strata on the peninsula between Bell Sound and Ice Fjord, which might afford some information as to the transition from the warm climate of the miocene period, which produced a luxuriant forest vegetation, to the ice masses of the present time; a more thorough examination of the Saurian strata at Cape Thorsden; an examination of the fragments of skeletons of whales found on the shores of Spitzbergen; a continuation of the collection and examination of the land and marine fauna and flora; dredgings at the greatest depths; magnetic and meteorological observations; geographical determinations of position, &c.

It was on this occasion that a week's stay was made at Bear Island, which lies about half-way between the north coast of Norway and Spitzbergen, and of which we should have liked to see a map and some views in Mr. Leslie's volume. Some of the results obtained in this visit are thus given by Mr. Leslie:—"Bear Island forms a pretty level plateau, two to three hundred feet above the sea, rising here and there into inconsiderable elevations and furrowed by small valleys, in the bottoms of which little streamlets seek their way among the naked stones. In the south-east the appropriately named Mount Misery rises perpendicularly from the sea to a height of about 1,200 feet, and in the south the Fuglefjeld is about the same height. On neither of these, however, is there any glacier or perpetual snow. It is not the formation of the island which gives it so desolate and forbidding an appearance, but the monotonous grey colour of the whole landscape. No trace of any grass turf is to be found in the interior, far less of any trees or bushes; only the Polar willow (*Salix polaris* and *herbacea*) with its thread-like stalks creeping in the moss, and two or three leaves, scarcely the size of a finger-nail, raised above it. Green patches in hollows where water has collected and formed a sort of marsh consist principally of mosses with scattered specimens of the Polar ranunculus (*Ranunculus sulphureus*) and a few other plants and grasses sparingly mixed with them. Except in these marshy places, the ground is nearly everywhere without the slightest trace of covering. By the combined action of water and frost the rocks have been literally frozen

[1] "The Arctic Voyages of Adolf Erik Nordenskjöld, 1858–1879." With Illustrations and Maps. (London: Macmillan and Co., 1879.) Continued from p. 611.

asunder, the limestone to small angular fragments, and the sandstone to larger or smaller blocks heaped one upon another. Such collections of stones cannot of course afford nourishment to higher plants, the more especially as any little mould that may be formed is immediately swept away by the wind or washed away by the rain. At long intervals in this wilderness of gravel and limestone there are found solitary specimens of the Arctic poppy (*Papaver nudicaule*), *Saxifraga*, *Draba*, *Sagina*, &c. Lichens, especially the larger species, occur here very sparingly and badly developed, though in spots the ground is almost covered by species which are exceedingly rare in the flora of Scandinavia. Where sandstone is the prevailing rock, the view is still more unpleasing. There is a considerable extent of surface where the only method of progression is by jumping from one block of stone to another, from which blocks all the higher plants, with the exception of a grass or two, are banished. The exterior of the island is more attractive. The rocks rise perpendicularly out of the sea, and as they consist of the looser formations, they have, in course of time, been shaped by the waves into the forms of arches, grottos, towers, columns, &c. The projecting rocky promontories are in some places found to be clothed with turf, and the perpendicular cliffs are richly hung with luxuriant *Cochlearia*.



I.

II.

III.

I. Inland Ice (A) extending into the Sea (D) and terminating in a steep front, 100 to 200 feet high. II. Inland Ice abutting on the bottom of an Ice-fjord, *i.e.*, a Fjord in which real Icebergs are formed. III. Inland Ice abutting on a Mud-bank.

"The explanation is easy. It is only the ledges where the sea-fowl sit that are thus ornamented, and it is only in the rich mould originating from these fowl that the plants can attain such luxuriance. This leads us to the most remarkable thing about Bear Island, its fabulous richness in sea-fowl. Indeed it may be said that the fowl are the proper inhabitants and owners of the island. There are, it is true, some mountain foxes, but they are very scarce, and the greater number only make a visit during winter, resembling in this the Polar bear, from which the island is named, as it cannot, at least now, support itself here in summer. During that season the walrus, which soon after the discovery of the island was found upon its shores in unheard-of numbers, and a little flock of which Keilhau had an opportunity of observing, is now sought for in vain. Even in winter, according to the latest observations, the Polar bear is an unusual guest here. . . . .

"The number of plants found by the botanists of the expedition was thirty-three, which, with the other five formerly observed, but not now found, makes the whole number of phanerogamous and higher cryptogamous plants found on Bear Island thirty-eight. The number of species of insects found was twelve. The number of marine animals was unexpectedly small in consequence of the unsuitable nature of the bottom. A great part of the island consists of strata belonging to the Mountain Limestone, in which are found in abundance mussel shells, corals, &c., showing that in times long past quite a different animal world lived in an almost tropical ocean. Two and a half centuries ago seams of coal were discovered on the north coast of the island, showing as black parallel bands on the perpendicular cliffs facing the sea. As the coal that occurs on Spitzbergen had been proved by the preceding Swedish expeditions to belong to the comparatively recent tertiary period, it had been considered probable that this was the case also with that found on Bear Island. But on examination being made impressions of plants were found, partly in the coal, partly in the sandstone separating the seams, which afforded indisputable evidence that the strata here belong to the true coal formation. Splendid *Sigillaria*, *Lepidodendra*, *Calamites*, and other characteristic fossils of the Coal period were taken, not without danger to life, from the perpendicular sea-cliffs on the north side of the island, and it was with deep regret that others had to be left behind because there was not time to cut them out of the rock."

Ice Fjord was again explored and much new geological data obtained, and various parts of the north coast examined. Of this expedition, the distinguished *savant*, Prof. Oswald Heer of Zürich, declared—"In my opinion

the Swedish Expedition, by the rich collections it has brought home, has achieved more, and more widened the horizon of our knowledge, than if it had returned merely with the information that the *Sofia* had hoisted her flag at the North Pole."

Nordenskjöld's last expedition to Spitzbergen was made in 1872-3, when a winter was passed in the island, with the intention of pushing north by the Seven Islands by means of sledges. As a preleminary to this, he paid a visit to Greenland in 1870, for the purpose of ascertaining

Glacier in Fair Haven.

the suitability of the Eskimo dog for sledging purposes. After careful observation Nordenskjöld came to the conclusion that reindeer were much better adapted to the work than dogs, and so it was decided to use the former in the contemplated expedition. While in Greenland Nordenskjöld made a journey of a few days into the interior and brought back some interesting results. He succeeded in penetrating only a distance of thirty miles,

Astronomical Observatory at Mussel Bay.

and that with great difficulty on account of the rough nature of the inland ice and the frequent crevasses that had to be passed.

"On the surface of the inland ice no stones were met with at a distance of more than a cable's length from the border; but everywhere there were to be found vertical cylindrical holes, a foot or two deep, from a couple of lines to a couple of feet in diameter and so close

to one another that it was impossible to find between them room for the foot, much less for a sleeping sack. . . . In these holes in the ice, filled with water and in no way connected with each other, Nordenskjöld found everywhere at the bottom of them, not only at the border but in the most distant parts of the inland ice which he visited, a layer some few millimetres thick, of grey powder, often conglomerated into small round balls of loose consistency. Under the microscope the principal substance of this remarkable powder appeared to consist of white angular translucent grains. There could also be observed remains of vegetable fragments; yellow, imperfectly translucent particles, with, as it appeared, evident surfaces of cleavage, possibly felspar, green crystals (augite), and black opaque grains, which were attracted by the magnet. 'The substance,' says Nordenskjöld, 'is not a clay, but a sandy trachytic mineral, of a composition (especially as regards soda) which indicates that it does not originate in the granite region of Greenland. Its origin appears to me, therefore, very enigmatical. Does it come from the basalt region? or from the supposed volcanic tracts in the interior of Greenland? or is it of meteoric origin? The octahedrally crystallised magnetic particles do not contain any traces of nickel. As the principal ingredient corresponds to a determinate chemical formula ($2R\dot{S}i^2 + \dot{A}\dot{l}\dot{S}i^3 + H$), it would perhaps be desirable to enter it under a separate class in the register of science; and for that purpose I propose for this substance the name Kryokonite (from κρύος and κόνις). 'When I persuaded our botanist Dr. Berggren, to accompany me in the journey over the ice,' he continues, 'I joked with him on the singularity of a botanist making an excursion into a tract, perhaps the only one in the world, that was a perfect desert as regards botany. This expectation was, however, not confirmed. Dr. Berggren's keen eye soon discovered, partly on the surface of the ice, partly in the above-mentioned powder, a brown polycellular alga, which, small as it is, together with the powder and certain other microscopic organisms by which it is accompanied, is the most dangerous enemy to the mass of ice, so many thousand feet in height and hundreds miles in extent. This plant has no doubt played the same part in our country, and we have it to thank, perhaps, that the deserts of ice which formerly covered the whole of northern Europe and America have now given place to shady woods and undulating cornfields. Of course a great deal of the grey powder is carried down in the

Canal in the Ice of North-East Land.

rivers, and the blue ice at the bottom of them is not unfrequently concealed by a dark dust. How rich this mass is in organic matter is proved by this circumstance among others, that the quantity of organic matter in it was sufficient to bring a large collection of the grey powder, which had been carried away to a distant part of the ice by several now dried-up glacier streams, into so advanced a state of fermentation or putrefaction, that the mass, even at a great distance, emitted a most disagreeable smell, like that of butyric acid.' "

The land gradually rose, and at their turning-point they had reached a height of 2,200 feet above the sea. During this visit to Greenland Prof. Nordenskjöld made some interesting observations on glaciers. "It is," he says, "a common error among geologists to consider the Swiss glaciers as representing on a small scale the inland ice of Greenland, or the inland ice which once covered Scandinavia. The real glacier bears the same relation to inland ice which a rapid river or brook does to an extensive and calm lake. While the glacier is in perpetual motion, the inland ice, like the water of a lake, is comparatively at rest, excepting at those places where it streams out into the sea by vast but short glaciers. If one of these glaciers, through which the ice-lake falls out into the sea, pass over smooth ground where the bottom of the ocean gradually changes into land without any steep breaks, steep precipitous glaciers are produced from which indeed large ice-masses fall down, but do not give rise to any real iceberg. But if the mouth of the fjord be narrow, the depth of the outlying sea great, and the inclination of the shore considerable, the result will be one of those magnificent ice fjords which Rink so admirably describes. No. II. in the diagram on p. 632 illustrates this more clearly.

"True icebergs are formed only in those glaciers which terminate in the manner indicated in No. II., though pieces of ice of considerable dimensions may fall from a steep precipice (No. I.). These various kinds of glaciers occur not only in Greenland, but in other ice-covered polar lands, *e.g.* in Spitzbergen, though on so much smaller a scale than in Greenland that one never meets in the surrounding waters with icebergs at all comparable in magnitude with those of Davis Straits.

"In Spitzbergen, and probably also in some parts of Greenland, the ice passes into the sea, as in No. III.

It was in this expedition that Nordenskjöld obtained

the two famous meteors, one of which, weighing nineteen tons is now in the Riks-Museum at Stockholm, and the other, nine tons, in the Museum of Copenhagen.

For the expedition of 1872-3 the Swedish government provided a steamer, the *Polhem*, and a brig, the *Gladan*, which were accompanied by the *Onkel Adam* as tender. Tromsö was left on July 30, and Ice Fjord was again visited, where a search was made in Coal Bay. Some little time was spent at Fair Haven, on the north of the island with the view of finding the place where the Dwarf Birch had been discovered in 1870 by Nathorst and Wilander. After a long fruitless search, and when all hope of finding it was given up and the return to the boat commenced, its dark green leaves were at last observed projecting from the surrounding moss. The dwarf birch found here, the *Betula nana, var. relicta*, TH. FRIES, is believed to be a survival from the time when Spitzbergen possessed a finer and warmer climate than now. Its height, as found here, did not exceed two feet, the thickest stem being from two to three lines in diameter. After the return to Sweden it was found by the help of the microscope that a stem of this thickness was about eighty years old. The yearly rings were exceedingly thin and faintly marked in several specimens, and in some parts of the stem, altogether indistinguishable. A well grown beautifully flowering specimen of the *Cardamine pratensis* also rewarded the search of the botanist, a *find* which was specially welcome, because this plant, though pretty widely distributed, is seldom found in flower on Spitzbergen.

Leaving Green Harbour on August 4, the *Polhem* proceeded on her voyage with the *Gladan* in tow, passing through the sound between Prince Charles Foreland and the mainland and anchoring on the 7th in Fair Haven for the purpose of regulating the chronometers at the place where Sabine and his companions spent three weeks in 1823, carrying on a series of physical and astronomical observations. The place which is situated on the south-western shore of the inner Norway island still bears the name of Sabine's observatory, and is distinguished by a great number of stones collected in a circle. While here, Wijkander carried on a series of magnetic observations at Sabine's observatory. Astronomical observations were also made, and two and sometimes three boats were at work dredging from morning till night. It ought also to be mentioned that on the drift-ice which the *Polhem* had encountered a short time before, Nordenskjöld had found small quantities of dust similar to that which he had discovered in the snow during a snow-storm at Stockholm in December 1871. This dust, which he believes to be of cosmic origin, contains metallic iron, cobalt, nickel, phosphoric acid, and a colloid organic substance. "However small and inconsiderable the quantity of this substance may be in proportion to the snow or water falling at the same time," he writes, "it may yet play an important part in the economy of nature; for example, by means of the phosphoric acid which it contains it may restore the fertility of the soil impoverished by repeated harvests. This observation ought also to be of great importance for the theory of meteors of the aurora, &c. Perhaps we should inquire whether in this phenomenon we are to seek the explanation of the abundance in which magnesia, which occurs plentifully in meteorites, is found to exist in certain distinct geological districts, and if an increase of the earth's mass, which is certainly minute, but which is going on continuously, ought not to produce very considerable changes in the geological theories now prevailing, which proceed on the supposition that the globe is as nearly as possible unaltered in mass since the first occurrence of plants and animals, and that the geological changes have always depended on changes of distribution in the mass over the surface of the earth, never upon the arrival from without of new constructive material for our globe."

While at Fair Haven the expedition was visited by Mr. Leigh Smith in his yacht, who promised that he would be among the first to look them up next summer. After a long enforced delay in Fair Haven on account of the ice, the expedition got away in September 1, but failed in every attempt to reach the Seven Islands. Mussel Bay, then, a small inlet off the east side of the mouth of Wijde Bay was chosen as the winter quarters of the expedition, and here all three vessels were ultimately locked in the ice. One large building was erected on shore besides magnetical, meteorological, and astronomical observatories. During the whole of the stay of the expedition here regular observations were carried on in their observatories. Provisions were short, and all had to be put on allowances; though scurvy broke out there was only one death, and altogether the winter was a dreary one, in spite of every effort to keep officers and men constantly employed.

Wijkander remained whole nights in his observatory bravely defying the cold and patiently overcoming the many difficulties attending astronomical observations made in such circumstances. In the cold weather the work out of doors was not stopped and the dredgings still went on, it being of great importance to ascertain whether the severe cold and the long darkness exercised any special influence upon the marine animal and vegetable world.

With the arrival of spring preparations were made for the ice-journey to the north, but as we have said already they did not get beyond the Seven Islands. Nordenskjöld makes some interesting observations on the rugged ice which prevented him attempting to push further northwards. "The ice we thus passed is formed not of colossal blocks or icebergs, but of angular blocks of ice, *not waterworn*, piled loosely over each other, so as to form pyramids, or walls of ice, up to thirty feet high, which were so close to each other that the space between them was frequently not large enough for our tent. The cause of the formation of these ice-walls, which were also observed by Wrangel on the north coast of Siberia, is probably to be sought for in the changes of volume which ice undergoes when its temperature is changed. According to Plücker and Geissler, the linear expansion-coefficient of ice is $= 0{\cdot}0000528$. If, therefore, ice of 0° C. be cooled to -15° C., cracks must arise which, for 1,000 metres, have a breadth of 32 inches. The cracks naturally freeze together immediately afterwards, and when the ice is again warmed, for instance to -5° C., a piling-up must take place of 21 inches per kilometre. During the course of the winter this phenomenon is repeated innumerable times, one layer of ice being piled upon another, till the whole ice-field forms a confused mass of blocks of ice heaped up against each other. Similar forces are also in operation in the crust of the earth, with less intensity, indeed, in consequence of the smaller expansion-coefficient of the rocks which compose it, and the inconsiderableness of the changes of temperature which occur in them, and the cracks thus formed may here come together again, provided no chemical or mechanical sediment has been deposited in them, as is, perhaps, often the case. On the other hand, the forces operate in the earth's crust during millions of years, and I doubt not that in the circumstances here noticed the cause of the strata being contorted, dislocated, *and thrown over each other* is to be sought for. This last, perhaps, to judge by the observations I had the opportunity of making on the polar ice, happens far oftener than we commonly suppose, and when it takes place there often occurs no considerable disturbance in the original horizontal position of the stratum. Certainly in most cases the veins filled with foreign minerals, by which the upper strata of the earth in particular are intersected in all directions, derive their origin from similar causes; that is

to say, from cracks which have in consequence of changes of temperature many times over opened and come together again, *provided they were not prevented by the falling in of débris*. This has, however, often taken place, considerable masses of sediments, formed chemically or mechanically, have frequently collected in the cracks, and during the immense duration of geological ages they have hardened and been metamorphosed to solid crystalline rocks—limestone, quartz, felsite, pegmatite, &c."

To make up for the disappointment of not being able to push beyond the Seven Islands, Nordenskjöld made a journey round the coast of North East Land, and right across the island from east to west. "North East Land," he tells us, "forms the most northerly of the four large islands, into which Spitzbergen is divided. Its extent from north to south is seventy-five and from east to west about ninety-two geographical miles. The whole interior is occupied by an ice-sheet 2,000 to 3,000 feet thick, to which the fall of snow (and rain) during summer and winter brings new material and which accordingly would be unceasingly increased, if the mass of ice did not, as is the case with all glaciers, flow out into the sea slowly but without intermission. The principal direction of the ice-stream in North East Land is towards the east, and the whole of the east coast is therefore occupied by a single precipitous ice-wall, insurmountable from the sea, which, being nowhere interrupted by rocky heights or tongues of land, forms the broadest glacier or skridjökel known to man. It is, for instance, considerably broader than the Humboldt glacier in Greenland described in such lively colours by Kane. Northwards, however, the ice-sheet of North East Land terminates with an even and gentle slope, which sometimes reaches the sea, but generally leaves a small stretch of ice-free land along the coast. On this side there is no obstacle to an advance into the interior, at least from precipitous slopes."

With regard to the glaciers which cover the surface of this island, Nordenskjöld writes :—

"Like the glaciers of Switzerland, of Greenland, and of Scandinavia, the glaciers of Spitzbergen are interrupted by clefts or fissures which often extend perpendicularly through the whole mass of ice several thousand feet thick. The occurrence of these fissures stands in close connection to the motion of the glacier, and there is therefore a smaller number to be met with where the glacier is spread over an extensive level field without interruption from rocky heights. Accordingly we had reason to suppose that clefts or fissures would not in any specially great number intersect the way we had chosen and I hoped besides that all the crevasses would have been filled with snow during the snow-storms of winter. This supposition was so far correct, inasmuch as fissures do not here occur in such numbers or of such size as in that part of the inland ice of Greenland which I examined along with Dr. Berggren in 1870—but deep almost bottomless openings do nevertheless occur in numbers sufficiently large to swallow up us and our sledges. They were the more dangerous as they were for the most part concealed by a fragile vault of snow, so that even when we stood on the edge of the cleft, it was only by boring with an ironshod stick, very often first by ourselves falling in, that we could assure ourselves of neighbourhood, direction, and extent."

In spite, however, of the innumerable concealed crevasses which they had to pass, the journey across the glacier-bound island was safely accomplished. The snow, he found, at a depth of four to six feet, passes into ice, being changed first to a stratum of ice-crystals, partly large and beautiful to the eye of the crystallographer, then to a crystalline mass of ice, and finally to a hard homogeneous glacier ice, in which, however, there could still be observed numerous cavities filled with air, compressed by the pressure of the overlying ice. When the ice-wall becomes on the melting of the ice too weak for the pressure of the inclosed air, these holes break up with a peculiar crackling sound, which in summer is continually to be heard from the pieces of glacier ice floating about in the fjords.

Many other extremely interesting observations were made on this journey as to the nature of Arctic land-ice. For example Nordenskjöld says :—

"In many respects there is a very essential difference between the ice-field over which we now travelled and the inland ice-field in Greenland, which was visited by me in 1870. The reason of this may perhaps be in a great degree the fact that in North East Land we wandered over a kind of *nevé region*, that is to say, over a part of the glacier where the surface is occupied by a layer of snow which does not melt away during summer, while in Greenland at the beginning of the month of July the snow upon the surface of the glacier was on the contrary already nearly completely melted. No trace of the glacier lakes, the beautiful and abundant glacier streams, the fine waterfalls and fountains, &c., which occur everywhere on the Greenland inland ice, could be observed here, and the configuration of the surface showed that such forms never occur, or only to a very limited extent. The melting of the snow clearly goes on upon Spitzbergen on too inconsiderable a scale for such phenomena to arise." Another curious phenomenon of this Spitzbergen ice was an area near Cape Mohn which was intersected by canals which for the most part ran parallel with each other, at some places at a distance of only 300 feet. The depth was up to 40 feet, the breadth 30 to 100. "Sometimes, also, there occurred other depressions, bounded in all directions by precipitous sides, of greater depth than the glacier canals, but of limited extent; these, perhaps, may most fitly be called by the name given them by the sailors—*docks* or *glacier docks*." With regard to the cause of these curious phenomena Prof. Nordenskjöld writes :—

"The inland ice of North East Land was at the time of our visit too much covered with snow for me to make out with complete certainty the way in which the glacier *canals* originate. That they were not river channels was clear. For they were much deeper than the river channels on the Greenland inland ice, where, however, the melting of the snow must proceed on a much more considerable scale than on Spitzbergen, and they occur in too close proximity at certain places (while at others they are completely absent) for them to be the beds of the channels of the streams, certainly very inconsiderable, which are produced here during the height of summer. There is a strong probability, on the other hand, that they originate from faults in the ice, strongly resembling those that are observed in the solid strata of the earth, and which, there as here, derive their origin from the alternate expansion and contraction of the strata or the ice in consequence of variations of temperature."

While Nordenskjöld was out on this sledge journey the work at Mussel Bay was still carried on. Soon after Nordenskjöld's departure Wÿkander commenced a series of pendulum observations. The tidal observations were also extended. Five minute observations were carried on at least a whole hour twice a day, at ebb and flood. After the long, dreary, and trying winter, our readers can easily imagine how welcome was the sight of Mr. Leigh Smith's yacht the *Diana*, steaming into the bay on June 12, with an abundant supply of much-needed comforts and luxuries.

From what we have written it will be seen that Mr. Leslie has been able to bring together from the wealth of material which exists on these various expeditions of Prof. Nordenskjöld, enough to render his volume one of general interest and great scientific value. We need not follow him in his narrative of Nordenskjöld's two journeys in 1875 and 1876 to the mouth of the Yenissei, for the purpose of proving that a sea-route from Europe along the north

coast of Europe and Asia was perfectly practicable to that river. Some of the scientific results of these expeditions were published in NATURE at the time, and it is well known that so far as the immediate object was concerned the expeditions were completely successful. Full details will be found in Mr. Leslie's volume. From what we have said it will be seen that comparatively young as Prof. Nordenskjöld is, he has done an amount of work rarely accomplished even in a long lifetime. Appended to Mr. Leslie's volume is a long bibliography of the published results of these expeditions of Nordenskjöld, and from this it is evident that they have borne rich fruit in nearly every department of science.

HERING'S THEORY OF THE VISION OF LIGHT AND COLOURS[1]

II.

BEFORE propounding his theory, the author thinks it necessary to devote one memoir—the fourth—to an essay, the object of which is to define clearly the nature of the sensations of black and white and their mixture gray. He remarks that it is a habit to treat visual sensations rather according to their physical origin than by their own nature; and this peculiarly influences the ideas entertained about the sensations of black and white. We know that physically, white light is a combination of rays of all wave-lengths, and we have no physical notion of black except a negative one, namely, as an absence of light of any kind. Hence, transferring our physics to our physiology, we consider that our sensation of white is a positive one, but that our idea of black arises simply from the absence of all sensation; or, to use a metaphor drawn from painting, black is our canvas, or background, on which all our sensation-pictures are drawn in white or colours; as a result of this, all our reasoning is confined to the pictures, while the background receives no attention.

The author, as one of the main points of his theory, strongly objects to this view. He denies that the natural unimpressed state of the visual sensation corresponds with black, appealing to every-day experience in support of the opinion. Any one who carefully examines his impressions after being for some time in a perfectly dark room, will observe a dark field, it is true; but if he tries, in imagination, to compare this with his sensation of a piece of the blackest velvet, he will be obliged to admit that the field is nothing approaching the latter in darkness; it is, in fact, only dark gray. Or as an easier and simpler test, let him compare the black after-image of a white disk with the general field given by his closed and darkened eyes, and he will observe a similar contrast.

The author's view is that the impression of black, like that of white, can only be derived from external sources; and that consequently black is a perfectly independent visual sensation, which should be studied physiologically like those of white, or red, or blue. On physiological grounds it is no more reasonable to consider black as the absence of white, than white as the absence of black, or blue as the absence of yellow, or to consider a sphere as the absence of solids of every other form.

On this principle he proceeds to discuss the sensation of gray. He objects to the usual mode of defining different shades of gray as merely different *intensities of light*. He considers any sensation of gray as a combination of the two independent sensations, black and white, in certain proportions; he calls this accordingly a *black-white* sensation, and he proposes to express it in a mathematical form. The full and perfect extreme sensations are practically unknown, and therefore no positive quantitative expressions can be used for them. But it is quite permissible to give an algebraical idea of the difference between intermediate gradations, and this may be done in the form of a ratio, or fraction, of which the two components express the assumed amounts of white and black respectively that are combined in the sensation. For example, there must be a practical gray (though we cannot identify its exact shade) which is intermediate between white and black, resulting from an equal force of each sensation. Here therefore if W = the force of the white sensation, and B = that of the black one, $\frac{W}{B} = \frac{1}{1}$ or $= 1$. For a lighter gray in which there is twice as much white as black, $\frac{W}{B} = \frac{2}{1} = 2$. And for a darker gray, in which there is twice as much black as white, $\frac{W}{B} = \frac{1}{2}$. On this principle the pure white sensation would be expressed by $\frac{W}{0} = \infty$, and the pure black sensation by $\frac{0}{B} = 0$.

It is possible, still retaining the principle, to give a more convenient expression for the brightness or lightness (*Helligkeit*) of any black-white sensation; thus, the degree of brightness may be expressed by the ratio which the *white element* bears to the *whole sensation*, or $= \frac{W}{W+B}$. Thus the brightness of the medium gray will be $= \frac{1}{1+1} = \frac{1}{2} = 0{\cdot}5$; and that of the mixture of two white to one black will be $= \frac{2}{2+1} = \frac{2}{3} = 0{\cdot}66$; and that of the mixture of two black to one white $= \frac{1}{1+2} = \frac{1}{3} = 0{\cdot}33$. The brightness of pure white will be $= \frac{1}{1+0} = 1$, and that of pure black $= \frac{0}{0+1} = 0$. This mode of definition corresponds to the usual practical idea of the *intensity* of white in gray, but it differs from it by acknowledging the independent black element in the composition.

In the fifth memoir we at length get a statement of the fundamental features of the author's theory, so far as the black-white sensation is concerned.

He begins by objecting to the treatment of white as a mixture of complementary colours, as blue and yellow, or red and green, or of all colours together, an idea which has arisen solely from physical considerations. No one, he says, can pretend that the least trace of any other colour can be distinguished in a pure white sensation; all that can be said is that the sensation of white is produced by a mixture of light of different wave-lengths. But the sensation is a perfectly independent one, like black, or red, and must be so considered in an investigation into the *rationale* of the visual perceptions.

Since the physiologist considers all sensations as called into existence by physical processes of the nervous system (for otherwise every physiological investigation would be objectless), he must assume so-called psycho-physical processes or movements which correspond to the sensations of black, of white, and of all shades between them. In what part of the nervous system these psycho-physical processes are situated it is impossible to say; suffice it that, somewhere in the nervous apparatus of the eye and the parts of the brain standing in functional relation therewith, a substance must be sought, with the changes or motion of which the sensation is bound up; this substance may be called the "visual substance" (*Sehsubstanz*).

The action of this substance may be studied in two ways: either *à priori*, by considering the physical influences brought to bear upon it, or, *à posteriori*, by considering the sensations resulting from its changes. The former mode has hitherto been of little profit, for

[1] Continued from p. 613.

although we can follow the ether vibrations to the retina, it has not been possible to trace what happens beyond. We can, indeed, compare the physical influences with the sensations produced, but we are obliged, in doing so, to skip over the intervening physiological steps where the chief interest lies. Hence the backward study of the processes, as inferred from their results, affords the best chance of success.

As to the general nature of the action of the visual substance, we have a choice between the idea of mechanical vibrations and that of chemical changes. Modern physiology points to the latter, for the general physiology of the nerves has sufficiently shown that all movement and all activity of the nervous substance produces chemical changes in it, and all our representations of changes of sensitiveness, fatigue, and restoration after activity, are founded on the assumption of such chemical changes. And however varied may be the views as to the details of this action, so far is certain that the continual presence of chemical processes in every vital and sensitive substance is a fact, and that material change is the most universal known property of every living thing.

It is therefore taken for granted that light produces chemical changes in the nervous apparatus of the visual organs; and what we term fatigue and change of sensitiveness depend, by general consent, on chemical changes of the sensitive substance. Hitherto, however, it has been customary only to consider this (so far as black and white are concerned) as an effect of *white* light; the element of black being neglected altogether, as already explained. The author proposes to correct this error, and he formulates his extended theory as follows:—

The two kinds of sensation which we call white (or light) and black (or aark) correspond to two distinct kinds of chemical action in the visual substance; and the various proportions in which these appear in the mixed sensation of gray, correspond to the same proportions of intensity of these two psycho-physical processes.

This is the simplest explanation conceivable, and it fulfils every condition demanded by general nervous physiology. We must assume a sensitive substance in the visual apparatus, which suffers a change by the action of light, and this change is generally believed to be a chemical one; and when the stimulating action is removed there must be a corresponding change in the other direction, giving a return to the normal condition. If the former change is assumed to be a partial consumption of matter, then the opposite change must be a restitution; if the former change is an analytical or disintegrating one, the latter must be a synthetical or reintegrating one, and so on.

Now the latter process, by which the living organic substance replaces the quantity lost by stimulation or activity, is usually called *assimilation*, and the author retains this name. The previous or contrary process, where the loss is caused by stimulation or activity, he calls *dissimilation*. Having to use these terms very often he denotes them by the letters A and D respectively.

These two processes result from the knowledge of physiology in general, and if they are correct, there is no reason why, as heretofore, only one of them, D, should be admitted to a theory of visual perception, and the other, A, excluded from it. The author's theory of the black-white sensation, therefore, embodies the proposition that *the sensation of white corresponds to dissimilation, and that of black to assimilation of the visual substance*, so that our visual sensations furnish a psychical expression of the correlation of the changes in the matter of this substance.

The following propositions are easily deducible from this principle.

The degree of lightness or darkness of a colourless visual sensation corresponds with the proportion between the intensities or magnitudes of the D and A actions respectively. For the medium gray these actions are equal, $\left(\frac{D}{A} = \frac{W}{B} = 1\right)$, so that the state of the visual substance remains constant. For a lighter gray D is greater than A, while for a darker gray the reverse is the case.

If we call all stimulating actions which favour dissimilation, D stimuli, and if we borrow from general physiology the proposition that the magnitude of the reaction with which an organ answers to its stimulus depends also on the mass of the excitable substance it offers to be acted on, we get the principle that the *magnitude of the dissimilation caused by a D-stimulus depends not only on the force of this stimulus, but also on the quantity of the excitable substance present.*

But the ability of an excitable substance to be set by a stimulus, in a state of excitation, is called its excitability (*Erregbarkeit*), and the previous proposition may be thus expressed:—

Every increase of the excitable substance necessitates a raising, every decrease a lowering, of the D-excitability of the visual organ. Hence the sensation of medium gray implies a uniformity, every brighter sensation a decrease, and every darker sensation an increase of the D-excitability. And it follows that if, at the same time, images of different brightness fall on two places of equal D-excitability, the place of the brighter sensation will have its excitability lowered, and *vice versa*.

The author further explains the law, that in any compound sensation, the prominence of any particular single one is expressed by the ratio which the magnitude or "weight" of that sensation bears to the sum of all the sensations present. For example, in a gray, the prominence of white $= \frac{W}{W + B}$. If the sensation of yellow is also present in an amount $= Y$, it will be $= \frac{W}{W + B + Y}$, and the prominence of yellow will be $= \frac{Y}{W + B + Y}$.

These being the chief features of the author's theory he goes on to show how it is applied to explain the various phenomena already mentioned, particularly those of subjective vision.

The first point necessary to be explained is what may be called the normal state of the visual organs, *i.e.*, the sensation experienced when the eyes have long been closed and darkened, as on awaking in a perfectly dark room. It has already been explained that this sensation, although dark, is far removed from what we know as black. It follows from the theory that in this state the D and the A actions should be in equilibrium, *i.e.*, about equally great or $\frac{D}{A} = 1$, according to which the sensation should correspond to the medium gray.

The author remarks on the fact that, comparing the actual sensation with the brightest sun-light on the one hand and the blackest known velvet on the other, it would seem to be far nearer the black than the white; but we have no reason to believe that the darkest sensation we can get at all approaches absolute blackness. He thinks it possible that if we could get rays as near the black end of the scale as sun-light is near the white end, we should find their effect as powerful. But such rays do not exist in nature, and in our ignorance of them we cannot define accurately what may or may not be the true medium gray.

Next is given an explanation of *Simultaneous Contrast*. The before-mentioned experiments have shown that when one part of the visual organ is stimulated by light, the effect is to darken the sensation in the parts around. The theory admits of the explanation of this in several ways; but the author prefers the following:—In a partial stimu-

lus by light a reaction is set up not only by the parts directly stimulated, but by the surrounding parts; the former through increased dissimilation, the latter through increased assimilation, which, however, is most powerful close to the lighted part, and diminishes fast with the distance from it.

This explains why, in a lighted room, the parts in shade appear black, much darker than our sensation with closed eyes, although the D-stimulus is equally active in both cases; and not only do the so-called dark parts really reflect some light, but a portion of dispersed light by objective irradiation enters the eye, which latter is strongest in the immediate neighbourhood of the bright object. But the increase of the assimilation prevents the perception of this light, and thus the ground is darkened, and the boundaries of the bright object are more sharply defined and brought out.

It is a result of this theory, that when two neighbouring parts of the retina are both stimulated by light at the same time, each reacts on the other by increased assimilation, the effect of which is to reduce the brightness of both. Hence, a small white surface is brighter than a large one of the same objective material. This may be easily seen by putting a large sheet of white paper, and a small strip of the same, both on a black ground. Or hold against the sky a large sheet of black paper, near the edge of which a small hole has been pierced; the point of light thus produced will be far more intense than that perceived round the edge of the paper. This is also the explanation of the great apparent brilliancy of the stars, the objective illumination of which is so very weak.

Explanation of *Simultaneous and Successive Light Induction*. Following up the process above described for simultaneous contrast, suppose the white object on the black ground to be further steadfastly observed for a longer time. The increase of assimilation in the parts immediately surrounding the white will cause an increase of the excitable substance, and will thus bring about an increase of excitability there. Hence the constantly working inner stimulus and the weak dispersed light of the black ground will acquire more dissimilating effect, while the assimilation gradually becomes weaker. Hence will follow an increase of apparent brightness on the parts previously darkened by contrast; this is *simultaneous light induction*. At the same time that the ground brightens in this way, the part of the visual organ impressed by the white surface suffers, by the prolonged dissimilation, a diminution of the excitable substance, whereby the excitability diminishes and the apparent brightness consequently diminishes also. If the contrast be made with only a slight difference in shade, and if the observation be carried on long enough, a phase will ultimately set in, in which by the gradual brightening of the ground and darkening of the whiter surface, they will both acquire the same appearance, and the distinction between them will disappear. This may be easily proved by experiment, but to prevent the confusing effect of the outlines, it is better shown by making, on white paper, dark patterns with shaded edges, when the effect will be soon apparent.

As the illumination of the light surface decreases it loses its power to favour the assimilation in the neighbouring dark parts, while the dissimilation under the influence of the inner D-stimulus not only goes on, but finds a greatly increased excitability to work upon; *i.e.*, according to the theory, the proportion $\frac{D}{A}\left(\frac{W}{S}\right)$ becomes greater, which means that the sensation increases in brightness. Hence, after sufficiently long steadfast observation, the bright-light space appears, and when the eyes are shut the sensation remains, as before described, giving *successive light induction*.

The explanation of *Successive Contrast* is given in four illustrations:—1. Observe fixedly a white stripe left between two large black surfaces; it will be seen that the original brightness gradually diminishes, and if the black surfaces be suddenly removed so as to leave an entirely white ground, the stripe will appear upon it as an after-image of a dark gray. This is, according to the theory, the result of the sudden bright illumination of the neighbouring parts; before this took place the dissimilation was powerful on the stripe, and (as before explained) excited an assimilation on the neighbouring black parts; this increased the D-excitability, and when the black surfaces were removed the white suddenly began to act with great power, setting up an assimilating action on the stripe where the excitability had been just before diminished, and so resulted the darkening effect on the latter.

2. Observe a small black stripe between two large sheets of white paper; it will at first appear very dark, but will gradually become lighter, and if the white sheets be suddenly removed, it will appear light on the black ground. This is the ordinary simultaneous and successive light induction already explained.

3. Lay a narrow white stripe on a black ground, observe it for a time, and then suddenly remove it; the place where it was will then appear blacker, and its neighbourhood lighter, than before. While observing the white stripe, the excitability upon it was diminished, and that around it increased, on the principles already explained: and on its removal the neighbouring parts were more impressed, and the place of the stripe less so, by the inner stimulus and the faint light of the general black ground.

4. Observe a black stripe on a white ground, and then suddenly remove it, leaving the whole field white. The place of the stripe will appear a brighter white surrounded by a darker space of a gray tinge. This is simply the converse of No. 3. The excitability was raised on the stripe and lowered around it; and when the whole field became active as a stimulus, the sensation was more powerful in the former place than the latter.

Lastly, the author devotes a chapter to the consideration of the *fatigue* of the visual organ. He says this may arise from two causes. When a light-stimulus is received, both a D-action and an A-action are set up, as previously explained: the D-action will naturally fatigue the organ by the dissimilation of the visual substance, but a similar result may follow also from the A-action if the assimilation goes on at a greater rate than fresh matter can be provided by the blood-supply. After looking at any very bright object, as the sun, and then covering the eyes, the after-image is not at first negative, but positive, and this bright impression may last for a long time, although, if the vision be thrown on white paper, the image will appear darker.

The explanation is as follows:—While looking at the bright object there is set up not only a strong dissimilation, but also a very considerable though less strong, assimilation. By the first the D-excitability will be greatly diminished, and by the latter the material in store will be quickly used up. Hence in the darkened eye, the sensation caused by the inner D-stimulus will be opposed only by a very weak A-action, so giving an after-impression of light, but of no great power. As the blood affords fresh matter, the equilibrium will be restored, and the appearance will die away.

In making the experiments hereinbefore mentioned on subjective vision, many different phases set in; these, though generally attributed to chance, are really due, in a large measure to the complicated influences of fatigue, caused as above described, and to their interference with the regular course of the light-induction and other processes hereinbefore described.

The author states, in conclusion, that he is far from believing that the theory he has developed is perfect, or incapable of correction, but he considers it comes nearer the truth than any other. WILLIAM POLE

(*To be continued.*)

NOTES

The following botanical appointments have been recently made by the Colonial Office, on the recommendation of the Director of the Royal Gardens, Kew:—H. Trimen, M.B. Lond., F.L.S., Senior Assistant in the Department of Botany, British Museum, to be Director of the Royal Botanic Garden, Ceylon, in the place of Dr. Thwaites, C.M.G., F.R.S., who retires on pension with the title of Honorary Government Botanist. D. Morris, B.A., Trin. Coll. Dubl., F.G.S., late Assistant-Director of the Royal Botanic Garden, Ceylon, to be Director of the Botanical Department, Jamaica. H. Marshall Ward, scholar of Christ's College, Cambridge, to be employed for two years as Cryptogamist in the investigation of the coffee-leaf disease in Ceylon. He will be subordinated to the Director of the Botanic Garden, and will have the use of the Assistant-Director's house. Mr. Morris and Mr. Ward were formerly students of the Science and Art Department.

Our readers will deeply sympathise with Sir John Lubbock under the heavy affliction with which he has been visited by the death of Lady Lubbock, which took place on the 20th instant. Her natural abilities were of no mean order, and the warm interest she took in all her husband's pursuits must have afforded him at once encouragement and aid in many of his undertakings. Her sympathies also extended to her husband's friends, and not a few of our readers will be able to call to mind the kind and hospitable reception which they have met with at her hands. Though for some years not in robust health, it was not, we believe, until within the last few weeks that any serious apprehension was entertained of the result of her illness. Lady Lubbock contributed a paper on the Shell-Mounds of Denmark to the volume of "Vacation Journals" for 1862-63; from time to time she was a contributor to Nature, and some few of her writings have appeared in a published form elsewhere; these, however, would afford but a poor criterion of all that she has directly and indirectly done towards the advancement of natural science.

It is with extreme regret that we record the death, after a long and painful illness, of Charles Henry Jeens, the well-known line engraver. Most of our readers are acquainted with the beautiful portraits of "Scientific Worthies" that appear from time to time in Nature, and many of them can doubtless testify from personal knowledge to the truth and accuracy of these portraits. Few artists ever possessed so fully as Mr. Jeens that esoteric faculty—which so many lack—for realising in an engraving the salient and best expression of a face and of making a portrait really characteristic and life-like. This faculty he held to the last, and increasing illness and pain only seemed to sharpen it. Apart from their value as excellent likenesses these portraits are of high artistic value. Mr. Jeens was noted for the firmness and delicacy of his work, and nowhere are these qualities better shown than in his small portraits. We are glad to say that before he died he had completed several fresh engravings for the series of "Scientific Worthies," which will be issued in due course and possess a mournful interest of their own. Mr. Jeens was only fifty-two years of age when he died.

Mr. C. P. Edison, nephew of the great American inventor, has just died at Paris at the early age of twenty-four. He was his uncle's principal assistant in the production of the loud-speaking telephone, and was sent over to London by him to exhibit that instrument before the Prince of Wales, the Royal Society, &c. He had of late been engaged in applying his uncle's system of quadruplex telegraphy between Paris and Brussels.

At the annual general meeting of the Cambridge Philosophical Society on Monday evening last, Prof. Alfred Newton, F.R.S., was elected President in the place of Prof. Liveing, who has served two years. The Vice-Presidents, in addition to the retiring President, are Prof. Stokes and Dr. Michael Foster. The Secretaries remain as before. New Members of the Council: Dr. Phear (Master of Emmanuel College), Prof. Hughes (Woodwardian Professor), and Mr. W. D. Niven, of Trinity College. Prof. Cayley and Mr. W. M. Hicks, of St. John's College, read papers, the latter on the Problem of Two Pulsating Spheres in a Fluid. Prof. Newton, in assuming the Presidency, said he felt bound to put aside all his feelings against holding this responsible position, in view of the wishes of the Council, and also considering that his election was to be regarded not only as a personal compliment, but as a tribute to those studies of which, by virtue of his position, he might be held to be representative. The next meeting of the Society is on November 10, and the junior secretary, Mr. Glaisher, is authorised to receive all communications relating to papers to be read before the Society.

The sixth meeting of Russian naturalists will be opened at St. Petersburg on January 1. The Committee is composed of professors of the St. Petersburg University, Beketoff, Petrushevsky, Ovsiannikoff, Tamintzin, Wagner, Menshutkov, and Snostrantseff. The meeting will last for ten days, and will have eight sections: Anatomy and Physiology; Zoology and Comparative Anatomy; Botany; Mineralogy, Geology, and Palæontology; Chemistry and Physics; Astronomy and Mathematics; Anthropology; and Scientific Medicine.

The last verification of the axes of the Gothard tunnel between Airolo and Göschenen was to be made this week. It is now confidently expected that the workmen from the two extremities of the tunnel will shake hands midway in the mountain before New Year's Day.

Prof. A. H. Sayce appeals to the public through the *Times* on behalf of a tour of exploration in Biblical lands, in which Mr. W. St. Chad Boscawen, the well-known Assyrian scholar, is at present engaged. Through the kindness of a few friends funds have been raised to carry him as far as Beyrout, whence he hopes to travel through Northern Syria and the Tigro-Euphrates Valley, visiting and examining on his way the sites of Carchemish and other Hittite cities, Nineveh, Calah, Assur (the ancient Assyrian capital), Balawat (from which Mr. Rassam obtained the bronze gates now in the British Museum), and Bagdad. Bagdad will be a centre for exploring Ur. The success of the expedition will, of course, largely depend on the funds at Mr. Boscawen's disposal, and Mr. Sayce hopes, therefore, that he will be assisted in his work by those interested in the archæology of the East. Subscription will be received by the treasurer of the fund, Mr. Edmond Beales, Osborn House, Bolton Gardens South, South Kensington.

On Saturday, October 25, the five academies constituting the Institute of France had a solemn meeting to award the biennial prize granted every two years by one of the academies. The turn this year being that of the Academy of Moral and Political Sciences, the prize was taken by M. Demolombe, dean of the Faculté de Droit of Caen, author of a voluminous work on legislation. The meeting was presided over by M. Daubrée, actual president of the Academy of Sciences, who delivered a very short inaugural address; but the learned geologist did not omit to make allusion to the unity of composition of the whole solar system as testified by the analysis of aërolites.

During the last few weeks the workmen engaged in making a road near Colberg, in Pomerania, found several indications that they were in the neighbourhood of an ancient burial place. The proprietor of the site, Herr von Kamecke, being solicitous for the preservation of any remains which might be found, had some excavations made under proper control. Twenty urns were

found; most of them had been shattered by the penetration of roots of trees and other causes, so that some of their contents only could be rescued. However, three large and two smaller urns were saved, quite uninjured, and two other large ones were taken up much shattered. The contents of the urns consisted chiefly of a sort of glass beads, rings, and needles of bronze and some small fragments of bronze wire. One iron needle and two iron rings were also found. All the things saved have been handed over to the Pomeranian Historical and Antiquarian Society.

SEVERAL German newspapers strongly deprecate the undignified tone which seems to have reigned amongst the participators in the recent celebration at Pompeii. It appears that the majority of the visitors treated the whole matter as an excellent joke, and behaved very much as they would have done at a fair or at some other Neapolitan *fête*. Many of the archæologists who had come long distances to be present at the celebration, left the dead city in disgust at the behaviour of the multitude, long before the proceedings were half over. One of the articles referred to expresses the hope that in the year 1979 the Neapolitans will have sufficiently improved in manners as well as gained in seriousness, to render a repetition of the disgraceful scene impossible.

THE London correspondent of the *Scotsman*, who is usually particularly well informed, states the Treasury has definitely decided not to ask Parliament for the cost of fitting up the new Natural History Museum at South Kensington and for the removal of the Natural History Department of the British Museum thereto till 1881. We are glad to be assured, however, that this statement should only be received as a rumour, and is not yet sufficiently authenticated. Let us trust that it will not be authenticated at all.

WE have received vol. iv. of the *Entomologische Nachrichten*, edited by Dr. F. Katter, Gymnasiallehrer am k. Pädogogium zu Putbus, Insel Rügen (Quedlinburg: Vieweg). We believe this magazine was started a few years ago as a monthly publication; but it is now issued fortnightly. It supplies a want that doubtless was long felt amongst German entomologists, affording a medium for constant intercommunication, and containing, moreover, many biological and other notes of much more than ephemeral value, notices of interesting excursions, discussions on the best means of preparing insects for scientific study, some good notices of new books, useful general bibliographic information, &c. We imagine most working entomologists in this country who can read German already see it, those who do not will find it to their advantage to possess it.

THE death is announced of Dr. Eugen Dühring, the well-known author of the "Kritische Geschichte der allgemeinen Principien der Mechanik" and "Privatdocent" in Berlin. He was born in 1833 in Berlin.

THE Committee appointed by the Royal Irish Academy to investigate the rocks of the districts of the Curlew Mountains and about Fintona, have discovered in the supposed "Old Red Sandstone" fossils of Silurian types.

THE thirteenth session of the Whitehaven Scientific Association was opened on the evening of Tuesday, October 21, when a *conversazione* was held in the Town Hall, which was largely attended by the members of the Association and their friends. The president for the year, Mr. A. Kitchin, F.C.S., delivered an address eulogistic of the labours of Dalton, with reference specially to the atomic theory. Crookes's tubes illustrating the properties of "radiant matter" were exhibited, and many objects of interest in science and art were also displayed in the room. The Association, which now numbers nearly 300 members, has been of considerable benefit in popularising science, mainly in the direction of series of lectures. It has formed the nucleus of a museum intended to represent local natural history, and has also established a library of scientific works. It is to be regretted that classes, in connection with the Association, have not hitherto been successful; further efforts in this direction are desirable in order that the work of the society may have the permanent value which systematic teaching alone can give.

A LOCAL anthropological exhibition is to be opened at Kazan by the local society of naturalists. We wish success to this young society, which displays a remarkable activity, and the publications of which contain many most valuable scientific papers.

IN consequence of the great efforts recently made for the improvement of the several Electrical specialties, a Chambre Syndicale of Electricity has been established in Paris. The number of subscribers is seventy-five, and the first meeting took place on October 27.

M. BROCA has presented to the Anthropological Society of Paris the head of Ataï, the principal mover of the great Kanaki rebellion in New Caledonia, and of a native enchanter who was killed in the same battle as the chief. These two heads had been cut off by a soldier, preserved in spirit and brought to Paris by him as a curiosity. They will be submitted to a thorough scientific examination.

FOR the first time perhaps in the history of electric lighting two rival magneto-electric machines are illuminating the same hall. The Lontin and Siemens generators and lights are exhibited at about 120 yards from each other in the large hall of the Palais de l'Industrie, at Paris. Each electrical machine is worked by steam, and consumes a certain amount of horse-power. The competition is too recent to offer yet any definite opinion on the respective merits of the apparatus confronting each other.

TELEGRAMS from Murcia state that the city and celebrated *Muerta* were inundated by an immense waterspout which was formed in the sea at a distance from the coast on the night of October 14–15. Salt water was discovered at a distance of 45 kilometres from the sea. Another great atmospherical commotion was experienced three days afterwards. A night snowstorm enveloped the whole of Austria and Switzerland, and in Vienna the thickness of the snowfall was several inches. It is the first time since 1852 that snow has fallen so early in Vienna, but not the earliest time on record, as in 1769 it fell on October 12.

A CEYLON paper states than an illustrated work on the Lepidoptera of the island is to be published at the expense of the Colonial Government.

RECENT intelligence from Victoria states that coal has been found on the Murray River near its confluence with the Murrumbidgee.

THE Phylloxera has appeared in the district of Geelong, Victoria.

A BRILLIANT meteor was observed at 5 P.M. on the 13th at Belluno, Italy. It was first bright red and then greenish white, and moved from east to west, at an angle of 45 deg. with the horizon.

THE Société française de Physique commences its meetings for the approaching session of 1879–80 on November 7.

WE would call attention to a very useful Index which has been begun in the *Gardeners' Chronicle* of October 11. It is intended to comprise references to the *more important* plants mentioned in the *Chronicle* from 1841 to 1878, including numerous original

descriptions by Lindley, Hooker, De Candolle, &c. This Index we think is likely to prove useful to botanists at large, and especially to those who are interested in the history of cultivated plants, and who may wish to know where to lay their hands on figures or descriptions of them.

THE applications of science at least seem to be obtaining some attention at the Antipodes; Stillwell and Co., of Melbourne, send us the following announcement of a new work to be published by them: "The Chemistry of Agriculture," by R. W. Emerson MacIvor, A.I.C., F.C.S., &c., lately Senior Demonstrator of Theoretical and Practical Chemistry, Anderson's University, Glasgow, with Appendices: Victorian Geology in its Relation to Agriculture, by Norman Taylor (of the late Geological Survey). The Conservation of Water for Agricultural and Pastoral Purposes, by G. Gordon, M.I.C.E. Suggestions on the Maintenance, Creation, and Enrichment of Forests, &c., by Baron von Mueller, K.C.M.G., F.R.S., &c.

THE Astro-physical Observatory on the Telegraphenberg, near Potsdam, was completed during September last, and has now been definitely handed over to its scientific directors.

PROF. SILVANUS THOMPSON has published a pamphlet of 74 pp. on apprenticeship schools in France, a subject on which he read a paper at the recent meeting of the British Association. The little book deserves the attention of all interested in technical education.

THE West London Scientific Association issue a very satisfactory Report for 1878–9.

THE museum of the St. Petersburg Academy of Sciences has made a valuable acquisition in the head of a *Rhinoceros tichorhinus*, very well preserved and covered with patches of hair. It is a part of a nearly complete carcass which was discovered on the banks of a tributary of the Yana, some 130 miles north of Verkhoyanak.

MESSRS. CASSELL have sent us the first two parts of a work on "European Ferns," illustrated by beautifully coloured plates. The text is by Mr. James Britten.

WE notice a useful publication undertaken by the Kieff Society of Naturalists, being a complete index of all works on mathematics, natural science, and medicine that have appeared in Russia during the years 1872 to 1877. The index for these five years has already appeared.

ANOTHER useful private undertaking is a weekly paper, *Rossiyskaya Bibliografia* (Russian and Slave Bibliography), appearing at St. Petersburg; it contains the titles of all Russian and Polish publications, with short notices about some of them.

MESSRS. GRIFFITH AND FARRAN will shortly publish a book entitled "On the Leads; or, What the Planets Saw." The object of the work is to bring the planets of our system into nearer acquaintance, making each give an account of itself to a little girl who watches them through her father's telescope on the leads of the house; their mythological character being made the mouthpiece of their astronomical and physical history. It is written and illustrated by Mrs. A. A. Strange Butson.

THE additions to the Zoological Society's Gardens during the past week include two Bonnet Monkeys (*Macacus radiatus*) from India, presented respectively by Mr. S. E. Phillips and Mr. J. E. Medley; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. Franklin; a Lesser Black-backed Gull (*Larus fuscus*), British, presented by the Rev. F. H. Addams; a Mississippi Alligator (*Alligator mississippiensis*) from North America, presented by Capt. J. H. Mortimer; a Garnett's Galago (*Galago garnetti*) from East Africa, a Banded Ichneumon (*Herpestes fasciatus*) from West Africa, a Sœmmerring's Antelope (*Gazella sœmmerringi*) from Abyssinia, two Dufresne's Amazons (*Chrysotis dufresniana*) from South-East Brazil, purchased.

THE SANITARY CONGRESS

THIS Congress continued its meetings at Croydon during last week, when several interesting addresses were given. Mr. Douglas Galton, in his address last Thursday, spoke of that large class of conditions which are the direct result of the circumstances to which man is exposed in consequence of living in communities. All living beings are in a continual condition of change, which results in their throwing off from the body matters which poison earth, air, and water, unless space, time, and opportunity are afforded for the counteraction of these deleterious effects. He showed how thus resulted both epidemic and zymotic diseases, the presence or absence of which in any locality, and the degree of their virulence depend on the sanitary surroundings. Cholera and dysentery are principally connected with the condition of the water supply; while an epidemic prevails the question whether a given population shall suffer or escape may almost be predicted from a chemical analysis of the drinking water. It is to the physiologist and the chemist that we must look for the causes from which these baneful effects arise, and what are the conditions which should be altered to prevent or remove them. The engineer steps in after these causes have been pointed out, and it is for him to design the methods of prevention or removal.

In places where many dwellings are congregated together the requirements for health may be classed as—first, those that are common to the community, such as the supply of good water, the removal of foul water, and the removal of refuse matter; and secondly, those which immediately concern the individual householder, such as the condition of his house and the circumstances of its occupation. It is the interest of every person in a community that every other member of the community should live under conditions favourable to health. Each year, as the population increases and as dwellings multiply, so does the importance of promoting these conditions increase; and so long as preventible diseases exist throughout the country, we must not delude ourselves with the idea that we have done more than touch the borders of sanitary improvement. There are few subjects in which so many professions of progress have been made in the last few years as in the theoretical knowledge of how to provide a healthy dwelling and a healthy town. Books innumerable have been written upon the question. Physiologists have invented every conceivable theory; patentees have invented every conceivable description of apparatus; engineers, architects, and builders overwhelm you with professions of their knowledge of sanitary principles, and millions of money have been spent in furthering the schemes they have devised; and yet, in spite of all these efforts, there are few houses and very few towns where you would not easily detect some grievous sanitary blunders. Mr. Galton believes this to be due, in the first place, to the fact that the majority of men prefer anything to thinking for themselves. They like to obtain their knowledge as they do their hats—from a shop, ready-made. In the second place, the sanitary education of the country has not been brought into a system. In the third place, it has always seemed to Mr. Galton that the system under which the Government advances money for sanitary works, whilst of great *primâ facie* advantage in one point of view, yet has its disadvantageous aspect. Mr. Galton then entered into some detail as to the best system to be adopted for encouraging and carrying out sanitary works.

He thinks that we should have reached a higher level of sanitary improvement in this country than now prevails, if the Government had limited itself to its more legitimate functions, viz., first, the enactment of laws requiring sanitary defects to be removed; and second, the promotion of measures for diffusing a sound education in sanitary knowledge; instead of pursuing the course of endeavouring to dictate the exact measures to be followed in each case. But it may be asked, What is sanitary knowledge? It is frequently assumed that drainage and water-supply are the principal subjects which are embraced in the term; but these only make up a small part of the subject. At the present time there does not exist any treatise which brings to a focus the various problems of mechanical and physical science, upon which the knowledge is based.

Mr. Galton then gives several instances in connection with the construction of houses to illustrate the variety of the problems to be solved. A sanitarian tells us that health depends on pure air and pure water. If a site is to be selected, it requires a consideration of its position with respect to its surroundings. It requires a knowledge of the temperature of the air and of the soil; what are the

prevailing winds; what is the amount and incidence of the rainfall; and what is the percolative capacity of the soil. The engineer cannot interfere with the general conditions of a climate, but he may produce important changes in the immediate surroundings of a locality: he may modify the condition and temperature of the soil; he may control atmospheric damp; he may arrange for the rapid removal of rainfall, or he may cause the rainfall to be retained in the soil, to be given out gradually in springs, instead of passing away in torrents to flood the neighbouring districts.

Mr. Galton showed by comparing the death-rate in the model lodging-houses in London with that of other districts that any extraordinary degree of unhealthiness in towns is unnecessary.

One important step in knowledge of sanitary construction is to learn how to obtain pure air in a building. What is pure air? What are the impurities which make the air of a town so different from the fresh air of the country? The volume of sulphuric acid from coal thrown up by our fires into London air is enormous. A cubic yard of London air has been found to contain nineteen grains of sulphurous acid. The street dust and mud is full of ammonia from horse-dung. The gases from the sewers pour into the town air. Our civilisation compels us to live in houses, and to maintain a temperature different from that out of doors. What are the conditions as to change under which we exist out of doors? Mr. Galton then proceeded to show that it is all but impossible to maintain a supply of pure air indoors. Any ventilating arrangements are only makeshifts to assist in remedying the evils to which we are exposed from the necessity of obtaining an atmosphere in our houses different in temperature from that of the outer air. On the other hand, means might be adopted to obtain as pure air as we can. Suspended matters exist in much smaller quantities at an altitude; at 100 feet they are greatly diminished; at 300 feet the air is comparatively pure. In Paris the air for the Legislative Assembly is drawn down from a height of 180 feet, so as to be taken from a point above many of the impurities of the town atmosphere. That is a reasonable and sensible arrangement, and might be usefully adopted in public buildings in towns. In the Houses of Parliament the so-called fresh air is taken from courtyards on the street level, from which horse traffic is not excluded. The maintenance of the standard of purity, or rather impurity, in a building, depends on ventilating arrangements. Ventilation chiefly depends on the laws which govern the movement of air, its dilatation by heat or contraction by cold; or, if ventilation is effected by pumps and fans, then upon the laws of the motion of air in channels, the friction they entail, and similar questions; therefore all these are matters for careful study. But when we apply the study to practice, other considerations occur. It may be summed up that, whatever the cubic space, the air in a confined space occupied by living beings may be assumed to attain a permanent degree of purity, or rather impurity, theoretically dependent upon the rate at which emanations are given out by the breathing and other exhalations of the occupants, and upon the rate at which fresh air is admitted, and that, therefore, the same supply of air will equally well ventilate any space, but the larger the cubic space the longer it will be before the air in it attains its permanent condition of impurity. Moreover, the larger the cubic space, the more easily will the supply of fresh air be brought in without altering the temperature, and without causing injurious draughts. "A room warmed by an open fire," Mr. Galton maintains, "is pleasanter than a room warmed by hot-water pipes. A warm body radiates heat to a colder body near to it. The heat rays from a flame or from incandescent matter pass through the air without heating it; they warm the solid bodies upon which they impinge, and these warm the air. Where the source of heat in a room consists of hot-water pipes, or low-pressure steam pipes, the air is first warmed, and imparts its heat to the walls. The air is thus warmer than the walls. When a room is warmed by an open fire, on the other hand, the warming is effected by the radiant heat from the fire, which passes through the air without sensibly warming it; the radiant heat warms the walls and furniture, and these impart their heat to the air. Therefore the walls in this case are warmer than the air. Consequently, in two rooms, one warmed by an open fire, and the other by hot-water pipes, and with air at the same temperature in both rooms, the walls in the room heated by hot-water pipes would be some degrees colder than the air in the room, and therefore colder than the walls of a room heated by an open fire; and these colder walls would therefore abstract heat from the occupants by radiation more rapidly than would be the case in the room heated by an open fire. And to bring the walls in the room heated with hot-water pipes to the same temperature as the walls in the rooms heated by the open fire would require the air of the room to be heated to an amount beyond that necessary for comfort, and therefore to a greater amount than is desirable. Besides theoretical knowledge, it is of essential importance that the sanitary architect, builder, or engineer, should have also practical technical knowledge of the subject. He should know what constitutes a good material and good workmanship. It is not only the officers of the army of sanitary constructors who require knowledge and education, but the foremen and the labourers, each in his own degree."

Prof. Corfield's address was on Sanitary Fallacies. After an interesting historical *résumé*, he dealt with some fallacies of the present day. Against all sanitary improvements whatever we find one argument continually brought—that things have gone on in the same way for many years, and there is no reason why they should be changed, that our forefathers from generation to generation lived under unsanitary conditions, and why should we not do the same? that cholera, or enteric fever, or diphtheria has never broken out in a place, or in a particular house, and so it need not be expected! Dr. Corfield showed how fallacious and mischievous this argument is. The arguments brought forward to support the spontaneous origination of the poisons of typhus and enteric fevers, of diphtheria, and of cholera, are most of them fallacious in the extreme, and the arguments advanced to prove the *de novo* origination of the poison of enteric fever, are of themselves sufficient to render it in the highest degree improbable. They are, indeed, so weak, that no one really capable of judging the value of a scientific argument, could from them come to any other conclusion than that the position was untenable. But a practical and very serious mischief has arisen from the spread of these doctrines. In the majority of cases no pains are taken to destroy the excremental discharges of patients suffering from such diseases, a neglect apt to lead to very dangerous consequences.

"But," Dr. Corfield went on to say, "there is still a great fallacy abroad in connection with the question of the removal of refuse matters from the vicinity of habitations. People talk and write as if the water-carriage system and the Conservancy systems stood upon the same footing—the principal of the one being the *immediate* removal of excretal matters from houses, and that of all the others being, as their name indicates, the keeping of such matters in and about the house for a certain time. The one is a correct principle, the other is a false one, and it is no argument at all to say that where the water-carriage system is badly carried out, the result may be worse than where the Conservancy system is carefully managed. In sanitary matters, as well as in everything else, we should follow correct principles. If we do not, but by arguments equally specious and fallacious, try to persuade ourselves that 'practically speaking' (according to the cant phraseology of the day) better results may be obtained by following false principles, nothing is more certain than that by an inexorable law of nature true principles will assert their position, and we shall be punished for our mistake by being landed in difficulties greater than we had to contend with at the outset. It is a very old and often-exposed fallacy to argue against the use of a thing from the abuse of it, and to argue against the water-carriage system because when surface drains have been called upon to do the duty of sewers, for which they were not intended, and of which they are not capable, or because the sewage has been turned into the water-courses, which have thus become unfit to supply water for domestic purposes, is an excellent example of this kind of fallacy."

Dr. Corfield went on to show that water containing the least quantity of organic matter must be regarded as dangerous, and that absolutely pure water should be insisted on, as the only safe form for sanitary purposes. With regard to dietetics, Dr. Corfield referred to the fallacies which existed for some time, as to the dietetic value of gelatine. He could not but think that it was a mistake to utterly condemn alcoholic liquors.

"There are those—" he said, "and I think there always will be—who cannot believe that the exquisite *bouquet* of the wines of France, of Italy, and of Spain is only fit to be smelt, there may even be those who are wicked enough to insinuate that if people do not taste them they show a lamentable deficiency in the cultivation of an important sense. He referred in conclusion to the anti-vaccination fallacy, and showed that statistics are dead against it.

Under the title of "Geology in Relation to Sanitary Science," Mr. Alfred Haviland gave some valuable hints as to what would be the practical difficulty in realising any of the dreams of a

future proper state of society. He showed that even under the most favourable conditions of physique and surroundings population would so increase that migration would be an absolute necessity, the emigrants thus finding themselves in conditions totally different from those they left. They would stand face to face with the stern reality of change; a change so great they could not realize it. Help is called for; and science like a good genius, extends her hand. The dreamer and the dream are gone. Large as our world may be, it never has been, and we have no grounds for believing it ever will be, a universal paradise: and without it becomes so, the people of the dream can never become realities. We find not a single writing in the stones that records evidence of either uniform climate, uniform soil, or uniform conditions of any kind whatever conducing to the perfection of existence either among the lower or the higher classes of animals. The very factor so necessary to the perfection of type, viz., health, is the great factor of productiveness; and this productiveness is the factor of destruction by overcrowding. Over and over again has this been recorded on the rocks.

Man has not only spoiled many of the sites which his ancestors wisely selected as vantage grounds against the foe, the flood, and the drought; but is hourly spoiling his own form by his artificial habits, and laying at the same time the foundation for a still further departure from a natural standard in his offspring. He is polluting the soil on which his habitations stand, he is befouling his water-courses and springs, and he is poisoning the air he breathes. He has thus created surroundings from which he can with difficulty escape. "Now I hold," Mr. Haviland said, "that any institute established for the purpose of teaching us the science of living in a cleanly and wholesome manner—as regards water, air, and soil—should first of all teach in its schools what has already been taught by such men as I have mentioned, as a wholesome restraint against the pride which a little knowledge engenders. Before we can boast of any sanitary science, let us be able to point to our researches on the climates, the soils, the diseases we find at home and abroad in our vast colonies. Let the crust of the earth in various parts of the globe be thoroughly examined in its relation to diseases—recollecting that had not man been born, there are certain spots in this earth that produce certain specific poisons, the chemical constitution of which we know nothing. Such spots should be mapped, after having been thoroughly investigated as to soil and climate, for the use of emigrants, colonists, and those in command of our expensive but necessary soldiery."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—During Prof. Maxwell's illness, Mr. W. Garnett is lecturing for him at the Cavendish Laboratory, on Voltaic Electricity, Electro-magnetism, and Electric Measurements; the lectures are experimental. Mr. Garnett is also giving a more elementary experimental course of lectures on Mechanics and Hydrostatics, adapted to candidates for the First M.B. and First Part of the Natural Sciences Tripos. Prof. Stuart's workshop will be open for pupils this term at the New Museums. Practical instruction in the use of tools in wood or metal is provided, and further practical instruction for those who already have a sufficient knowledge of the use of the tools. During the present term his lectures will be on Mechanism. Mr. W. J. Lewis, M.A., Fellow of Oriel College, Oxford, has been incorporated as M.A. of Cambridge, and entered at Trinity College. Prof. W. H. Miller, F.R.S., Professor of Mineralogy, being in ill-health, Mr. W. J. Lewis has been appointed his deputy for twelve months, and Prof. Miller has assigned two-thirds of his whole annual stipend to his deputy. Mr. Lewis has for some time been working very assiduously in the Mineralogical Museum, and is now lecturing on Mineralogy, while in the Easter Term he intends to lecture on Crystallography and Crystallographic Physics. Next term Prof. Stuart's lectures will be on the Theory of Structures. Prof. Challis's lectures on Practical Astronomy are postponed on account of ill-health. Prof. Cayley will lecture this term on Differential Equations.

THE City and Guilds of London Institute for the Advancement of Technical Education, announce the opening of their technical classes, at Cowper Street School, Finsbury. In the section of applied physics, Mr. W. E. Ayrton will deliver a course of twelve lectures on "Some of the Practical Applications of Electricity and Magnetism," commencing on Monday, November 3, at 7 p.m. In that of applied chemistry, Dr. H. Armstrong, F.R.S., will deliver a similar course on "The First Principles of Chemistry," commencing Wednesday, November 5, at 8 p.m. An inaugural lecture will be delivered by Mr. Ayrton, on Saturday, November 1, at 8 p.m., on "The Improvement Science can Effect in our Trades, and in the Condition of our Workmen." A class in connection with this for the study of blowpipe analysis and assaying, will be commenced next week at the Birkbeck Institution, by Mr. G. Chaloner, F.C.S.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, October 20.—M. Daubrée in the chair.—The following papers were read:—Researches showing the power, the rapidity of action, and the varieties of certain inhibitory influences of the brain on itself or on the spinal cord, and of this latter centre on itself or on the brain, by M. Brown-Séquard.—Discovery of a small planet, by Mr. Peters (telegram from the Smithsonian Institution).—Observation of the planet 206, Peters, at the Paris Observatory, by MM. Henry.—Observations of declination, inclination, and horizontal intensity in the basin of the Mediterranean, by M. de Bernardière. These observations were made during a voyage of the training-ship, *La Flore*, in 1878-79. The numbers for some twenty-six places are tabulated.—On whole functions, by M. Picard.—On the Laurent saccharimeter, by M. Laurent. Two improved models were presented, giving more light and distinctness, while the reflections in the tubes are suppressed.—New researches on the mode of union of cells of the mucous bodies of Malpighi, by M. Ranvier. These cells, formed of masses of protoplasm with nuclei, are united by protoplasmic filaments, which are common to them and each of which does not result from junction of two filaments placed end to end, nor is the nodule occupying their middle the mark of a junction or juxtaposition; it is an elastic organ, which allows of easy enlargement of the spaces destined for circulation of nutritive juices between the cells.—On asphyxic glycæmia, by M. Dastre. Cl. Bernard affirmed that a prolonged asphyxic state destroyed the glycogen of the liver, and made the sugar disappear from the blood. Some physiologists hold, on the contrary, that in accordance with Lavoisier's theory, sugar accumulates in the blood when the oxygen (for its combustion) is diminished. M. Dastre considers we must distinguish between the effects of rapid asphyxia, immediately consequent on withdrawal of oxygen, and the consecutive effects of slow asphyxia (such as wasting of tissues and exhaustion of reserves). Rapid asphyxia may be realised in two ways, making an animal breathe air confined in a closed vessel, or making it breathe in rarefied air constantly renewed. He tried both on dogs, and found the quantity of sugar in the blood to vary in contrary direction to the quantity of oxygen (less oxygen, more sugar).

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

"To the solid ground
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No. 496, Vol. 20] THURSDAY, MAY 1, 1879 [Price Sixpence

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DIARY OF SOCIETIES.

London

THURSDAY, May 1.

Royal Society, at 8.30.—A Magnetic Survey of the Fortieth Parallel in North America between the Atlantic Ocean and the Great Salt Lake, Utah: Prof. Thorpe.—On Certain Definite Integrals occurring in Spherical Harmonic Analysis, and on the Expansion in Series of the Potentials of the Ellipsoid and the Ellipse: W. D. Niven.—On the Origin of the Parallel Roads of Lochaber, and their Bearing on other Phenomena of the Glacial Period: Prof. Prestwich.

Chemical Society, at 8.—On the Volumes of Liquids at their Boiling Points obtainable from Unit Volumes of Gases: Dr. W. Ramsay.—On a Method of Precipitating Manganese entirely as Dioxide, and its Application to the Volumetric Determination of Manganese: S. Pattinson.—On the Determination of Nitric Acid as Nitric Oxide by Means of its Action on Mercury: R. Warrington.

Royal Institution, at 2.—Annual Meeting.

Linnean Society, at 8.—Note on the Occurrence of a Restiaceous Plant in Cochin China: Dr. Maxwell Masters.—On the Structure of the Pouched Rats of the Genus *Heteromys*: Dr. J. Murie.—Nutrition in its Relation to the Fertilisation of Flowers: Thos. Meehan.

FRIDAY, May 2.

Royal Institution, at 9.—Action of Anæsthetics: Prof. McKendrick.
Society of Arts, at 8.—The Wild Silks of India: Thos Wardle.
Geologists' Association, at 8.—The Dinosauria: Prof. Seeley.

SATURDAY, May 3.

Royal Institution, at 3.—Architecture: H. H. Statham.

MONDAY, May 5.

Geologists' Association.—Excursion to Newbury.
Medical Society, at 8.30.
Victoria Institute, at 8.
Society of Arts, at 8.—Recent Advances in Telegraphy: W. H. Preece.
Royal Institution, at 5.—General Monthly Meeting.
Odontological Society.—Action of Nicotine on the Teeth.

TUESDAY, May 6.

Zoological Society, at 8.30.—On Additions to the Menagerie: The Secretary.—Description of a New Species of Woodpecker, from the Island of Tyzus Sima, near Japan: Rev. H. B. Tristram.—Descriptions of New Genera and Species of Asiatic Lepidoptera Heterocera: F. Moore, F.Z.S.

Statistical Society, at 7.45.—The Feasibility of Compulsory Education in Ireland: W. Neilson Hancock, LL.D.

Royal Institution, at 3.—Schumann: Ernest Pauer.

WEDNESDAY, May 7.

Society of Arts, at 8.—The Government Patent Bill: W. L. Wise.
Entomological Society, at 7.

THURSDAY, May 8.

Royal Society, at 8.30.—On the Sensitive State of Electrical Discharges through Rarefied Gases: W. Spottiswoode and J. F. Moulton.—On the Action of Solid Nuclei: C. Tomlinson.—On the Results of the Magnetical Observations made by the Officers of the Arctic Expedition, 1875–76: Staff-Commander E. W. Creake.—On the Relation between the Diurnal Range of Magnetic Declination and Horizontal Force as observed at the Royal Observatory, Greenwich, during the Years 1841 to 1877, and the Period of Solar Spot Frequency: W. Ellis.

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Society of Arts, at 8.—Alizarine and Allied Colouring Matters: W. H. Perkin.

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Royal Institution, at 3.—Architecture: H. H. Statham.

MONDAY, May 12.

Royal Geographical Society, at 8.30.—On the Modification of the External Aspects of Organic Nature produced by Man's Interference: Prof. G. Rolleston.

Society of Arts, at 8.—Recent Advances in Telegraphy: W. H. Preece.

TUESDAY, May 13.

Anthropological Institute, at 8.—Ethnology, Mythology, and Philology of Races of Early Culture, Babylonians, Etruscans, Egyptians, Japanese, &c.: Hyde Clarke.—Notes on some Irish Affinities: A. L. Lewis.—History of the South-Western Barbarians. Translated from the Chinese: A. Wylie.—The Spread of the Slaves, Parts 2 and 3, Sections 1 and 2: H. H. Howorth.

Royal Institution, at 3.—German Literature: Prof. Hillebrand.

West London Scientific Association, at 8.

Horticultural Society, at 1.—Scientific Committee.

WEDNESDAY, May 14.

Royal Microscopical Society, at 8.—On the Occurrence of Recent Heteropora: A. Wm. Waters.—New Species and Varieties of Diatomaceæ from the Caspian Sea: A. Grunow.

Geological Society, at 8.—On the Pre-Cambrian Rocks of Caernarvonshire: Prof. T. McK. Hughes.—Notes on the Structure of the Palæozoic Districts of West Somerset: A. Champernowne and W. A. E. Ussher.—The Whin Sill of Teesdale as an Assimilator or the Surrounding Beds: C. T. Clough.—On the Augitic Rocks of the Canary Islands: Salvador Calderon. Communicated by the President.

Society of Arts, at 8.—The Automatic Hydraulic Brake: E. D. Barker.

THURSDAY, May 15.

Royal Society, at 8.30.

Royal Institution, at 3.—Dissociation: Prof. Dewar.

Society of Arts, at 8.—History of Alizarine, &c.: W. H. Perkin.

FRIDAY, May 16.

Royal Institution, at 9.—Etude optique de l'Elasticité: Prof. Cornu.

SATURDAY, May 17.

Royal Institution, at 3.—Architecture: H. H. Statham.

Geologists' Association.—Excursion to Watford.

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NATURE

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No. 498, Vol. 20] THURSDAY, MAY 15, 1879 [Price Sixpence

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DIARY OF SOCIETIES.

LONDON

THURSDAY, MAY 15.

ROYAL SOCIETY, at 8.30.—Note on a Recent Communication by Messrs. Liveing and Dewar: J. N. Lockyer, F.R.S.—On an Induction-Current's Balance, and Experimental Researches made therewith: Prof. D. E. Hughes.—On the Capillary Phenomena of Jets: Lord Rayleigh, F.R.S.
SOCIETY OF ANTIQUARIES, at 8.30.—Occurrence and Origin of the Greek Fret, or Key Pattern, in Mexico and Peru: R. P. Greg.—Remarkable Finds of Bronze Celts in Italy: W. M. Wylie, M.A.
CHEMICAL SOCIETY, at 8.—On Nitrification, Part 2: R. Warington.—On Alkaloids of the Veratrums, Part 3: Dr. Wright and Mr. Luff.—On Alkaloids of the Veratrums, Part 4: Dr. Wright.—On Alkaloids of the Aconites and on Japanese Aconite Roots: Dr. Wright and Mr. Luff.—On the Action of Hydrochloric Acid on Manganese Dioxide: S. Pickering.—The Composition of Milk in Health and Disease: A. W. Blyth.—Notes on the Effect of Alcohol on the Chemistry of Digestion: W. H. Watson.
ROYAL INSTITUTION, at 3.—Dissociation: Prof. Dewar.
SOCIETY OF ARTS, at 8.—History of Alizarine, &c.: W. H. Perkin.
ZOOLOGICAL GARDENS, at 5.—The Pleasures of Zoology: Prof. J. R. Greene.

FRIDAY, MAY 16.

ROYAL INSTITUTION, at 9.—Etude optique de l'Elasticité: Prof. Cornu.

SATURDAY, MAY 17.

ROYAL INSTITUTION, at 3.—Architecture: H. H. Statham.
GEOLOGISTS' ASSOCIATION.—Excursion to Watford.

MONDAY, MAY 19.

SOCIETY OF ARTS, at 8.—Recent Advances in Telegraphy: W. H. Preece.
VICTORIA INSTITUTE, at 8.—Ethnology of the Pacific: Rev. S. J. Whitmee.
ROYAL INSTITUTION, at 3.—The Intellectual Movement in Germany: Prof. Hillebrand.

TUESDAY, MAY 20.

ZOOLOGICAL SOCIETY, at 8.30.—Description of a Portion of a Mandible and Teeth of a Large Extinct Kangaroo (*Palæorchestes crassus*) from Ancient Fluviatile Drift, Queensland: Prof. Owen, C.B.—Descriptions of New Species of Halticidæ: Martin Jacoby.—On a Fourth Collection of Birds made by the Rev. G. Brown, C.M.Z.S., on Duke of York Island and in its Vicinity: P. L. Sclater.
ROYAL INSTITUTION, at 3.—Suggestions to Students and Readers of History: T. R. Seeley.
STATISTICAL SOCIETY, at 7.45.—On some Effects of a Crisis on the Banking Interest: John B. Martin, M.A.

WEDNESDAY, MAY 21.

METEOROLOGICAL SOCIETY, at 7.—On Observations of the Velocities of the Wind and on Anemometers: G. A. Hagemann.—On the Relation between the Height of the Barometer and the Amount of Cloud, as Observed at the Kew Observatory: G. M. Whipple, F.R.A.S.
ROYAL SOCIETY OF LITERATURE, at 8.—The Authorship of Shakespear's Plays: Sir Patrick Colquhoun, Q.C.
CROYDON MICROSCOPICAL SOCIETY, at 8.30.
SOCIETY OF ARTS, at 8.—Edison's New Telephone: C. W. Cooke.

THURSDAY, MAY 22.

ZOOLOGICAL SOCIETY, at 5.—Tails: Prof. Mivart.
ROYAL INSTITUTION, at 3.—Dissociation: Prof. Dewar.
SOCIETY OF ARTS, at 8.—Alizarine: Prof. Perkin.

FRIDAY, MAY 23.

ROYAL INSTITUTION, at 9.—Multiple Telegraphy: W. H. Preece.
QUEKETT MICROSCOPICAL CLUB, at 8.—On some Improvements in Microscopical Turn-Tables: C. Spencer Rolfe.—On Stained Sections of Animal Tissues and how to Prepare them: J. W. Groves.
SOCIETY OF ARTS, at 8.—The Harbour of Kurachee: W. J. Price.

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DIARY OF SOCIETIES.

London

THURSDAY, May 22.

Zoological Society, at 5.—Tails: Prof. Mivart.
Royal Institution, at 3.—Dissociation: Prof. Dewar.
Society of Arts, at 8.—Alizarine: Prof. Perkin.

FRIDAY, May 23.

Royal Institution, at 9.—Multiple Telegraphy: W. H. Preece.
Quekett Microscopical Club, at 8.—On some Improvements in Microscopical Turn-Tables: C. Spencer Rolfe.—On Stained Sections of Animal Tissues and how to Prepare them: J. W. Groves.
Society of Arts, at 8.—The Harbour of Kurachee: W. J. Price.

SATURDAY, May 24.

Royal Institution, at 3.—Swift: Prof. H. Morley.
Physical Society, at 3.—On a New Harmonograph: W. J. Wilson.—On a New Induction Balance: Prof. Hughes.
Linnean Society, at 3.—Anniversary Meeting and President's Address.

MONDAY, May 26.

Royal Geographical Society, at 1.—Anniversary.
Geologists' Association.—Excursion to Knockholt and Sevenoaks.
Royal Institution, at 3.—German Literature: Prof. Hillebrand.

TUESDAY, May 27.

Royal Institution, at 3.—Suggestions to Students and Readers of History: Prof. J. R. Seeley.
Anthropological Institute, at 8.—Notes on Fetichism: Hodder M. Westropp.—Letters to Prof. Max Müller on the Kabi Dialect of Queensland: John Matthew.
West London Scientific Association, at 8.
Horticultural Society.—Great Summer Show.—Scientific Committee at 1.
Metropolitan Scientific Association, at 7.
Society of Arts, at 8.—Civilisation and Barbarism in Africa: Edward Hutchinson.

WEDNESDAY, May 28.

Geological Society, at 8.—On the Endothiodont Reptilia, with Evidence of the Species *Endothiodon uniseries*, Owen: Prof. R. Owen, F.R.S.—Note on *Eucœmerotus*, Hulke, = *Ornithopsis*, Seeley, = *Bothriospondylus*, Owen, = *Chondrosteatosaurus*, Owen: J. W. Hulke, F.R.S.—Description of the Species of the Ostracodous Genus *Bairdia*, M'Coy, from the Carboniferous Strata of Great Britain: Prof. T. Rupert Jones, F.R.S., and James W. Kirby.—Report on a Collection of Fossils from the Bowen River Coal-field and the Limestone of the Fanning River, North Queensland: R. Etheridge, Jun.—On a Fossil *Squilla* from the London Clay of Highgate, part of the Wetherell Collection in the British Museum: Dr. Henry Woodward, F. R.S.—On *Necroscilla Wilsoni*, a Supposed Stomatopod Crustacean from the Middle Coal-measures, Cossall, near Ilkeston, Derbyshire: Dr. Henry Woodward, F.R.S.—On the Discovery of a Fossil *Squilla* in the Cretaceous Deposits of Hâkel, in the Lebanon, Syria: Dr. Henry Woodward, F.R.S.—On the Occurrence of a Fossil King-Crab (*Limulus*) in Cretaceous Formation of the Lebanon Syria: Dr. Henry Woodward, F.R.S.
Horticultural Society.—Great Summer Show.

THURSDAY May 29.

Royal Society, at 8.30.—On the Conduction of Heat in Ellipsoids of Revolution: Prof. C. Niven.—On a New Method of Investigating the Magnetic Lines of Force in Magnets, demonstrating the Obliquity of the Equator and Axis of Bar-Magnets: Dr. Shettle.—Preliminary Report to the Committee on Solar Physics on a Method of detecting the Unknown Inequalities of a Series of Observations: Professors B. Stewart and W. Dodgson.
Zoological Gardens, at 5.—Parrots: P. L. Sclater.
Royal Institution, at 3.—Dissociation: Prof. Dewar.
Horticultural Society.—Great Summer Show.

FRIDAY, May 30.

Royal Institution, at 9.—Colour-Sense in Insects: Grant Allen.
Horticultural Society.—Great Summer Show.

SATURDAY, May 31.

Royal Institution, at 3.—Swift: Prof. Morley.

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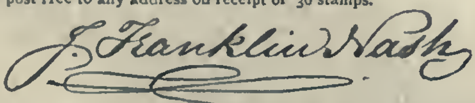

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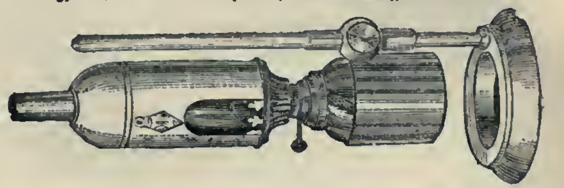

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DIARY OF SOCIETIES.

LONDON

THURSDAY, MAY 29.

ROYAL SOCIETY, at 8.30.—On the Conduction of Heat in Ellipsoids of Revolution: Prof. C. Niven.—On a New Method of Investigating the Magnetic Lines of Force in Magnets, demonstrating the Obliquity of the Equator and Axis of Bar-Magnets: Dr. Shettle.—Preliminary Report to the Committee on Solar Physics on a Method of detecting the Unknown Irregularities of a Series of Observations: Prof. B. Stewart and W. Dodgson.—Researches on Explosives. No. II. Fired Gunpowder.
ZOOLOGICAL GARDENS, at 5.—Parrots: P. L. Sclater.
ROYAL INSTITUTION, at 3.—Dissociation: Prof. Dewar.
HORTICULTURAL SOCIETY.—Great Summer Show.

FRIDAY, MAY 30.

ROYAL INSTITUTION, at 9.—Colour-Sense in Insects: Grant Allen.
HORTICULTURAL SOCIETY.—Great Summer Show.

SATURDAY, MAY 31.

ROYAL INSTITUTION, at 3.—Swift: Prof. Morley.

MONDAY, JUNE 2.

ROYAL INSTITUTION, at 3.—German Literature: Prof. Hillebrand.—At 5.—General Monthly Meeting.

TUESDAY, JUNE 3.

ZOOLOGICAL SOCIETY, at 8.30.—A Description of the Vessels of the Neck and Head of the Ground Hornbill: W. Ottley.—On the Specific Identity of the British Marten Cats: E. R. Alston.—On Birds Collected by the late Mr. T. K. Salmon in the State of Antioquia, U.S. of Colombia: Messrs. Sclater and Salvin.
ROYAL INSTITUTION, at 3.—Study of History: Prof. Seeley.

WEDNESDAY, JUNE 4.

ENTOMOLOGICAL SOCIETY, at 7.

THURSDAY, JUNE 5.

CHEMICAL SOCIETY, at 8.—On Eardenine: Dr. Stenhouse and Mr. Groves.—On the Theory of Fractional Distillation: F. D. Brown.—On the Action of Organo-Zinc Compounds on Quinones: F. R. Yapp.—On Chlorstannic Acid: J. W. Mallet, F.R.S.—On Indigo-Purpurin and Indi-Rupin: E. Schunck, F.R.S.—Third Report to the Chemical Society on some Points in Chemical Dynamics: Dr. Wright, Mr. Luff, and Mr. Rennie.
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LINNEAN SOCIETY, at 8.—Ferns of Northern India: C. B. Clarke.—Structure and Development, Skull of Urodelous Amphibia: Prof. W. K. Parker.—Lichens of English Polar Expedition, 1875–76: Prof. Th. M. Fries, of Upsala.—Mollusca of *Challenger* Expedition, Part IV.: Rev. R. Boog Watson.
ZOOLOGICAL GARDENS, at 4.—Snakes: Prof. Huxley.

FRIDAY, JUNE 6.

ROYAL INSTITUTION, at 9.—Spectroscopic Investigation: Prof. Dewar.
GEOLOGISTS' ASSOCIATION, at 8.

SATURDAY, JUNE 7.

ROYAL INSTITUTION, at 3.—Prof. Morley.

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DIARY OF SOCIETIES.

LONDON

THURSDAY, JUNE 5.

CHEMICAL SOCIETY, at 8.—On Eardenine: Dr. Stenhouse and Mr. Groves.—On the Theory of Fractional Distillation: F. D. Brown.—On the Action of Organo-Zinc Compounds on Quinones: F. R. Yapp.—On Chlorstannic Acid: J. W. Mallet, F.R.S.—On Indigo-Purpurin and Indi-Rupin: E. Schunck, F.R.S.—Third Report to the Chemical Society on some Points in Chemical Dynamics: Dr. Wright, Mr. Luff, and Mr. Rennie.
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SATURDAY, JUNE 7.

ROYAL INSTITUTION, at 3.—Prof. Morley.

MONDAY, JUNE 9.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Flora of the European Alps, and its Connection with that of other Regions of the Earth: J. Ball, F.R.S.

TUESDAY, JUNE 10.

ROYAL INSTITUTION, at 3.—German Literature: Prof. Hillebrand.
ANTHROPOLOGICAL INSTITUTE, at 8.—Notes on some Cornish and Irish Prehistoric Monuments: Miss A. W. Buckland.—Some Facts about Japan and its People, &c.: C. Pfoundes.
HORTICULTURAL SOCIETY, at 1.—Scientific Committee.
WEST LONDON SCIENTIFIC ASSOCIATION, at 8.

WEDNESDAY, JUNE 11.

GEOLOGICAL SOCIETY, at 8.—On a Mammaliferous Deposit at Barrington, near Cambridge: Rev. O. Fisher, M.A.—The Pre-Cambrian Rocks of Shropshire, Part 1: C. Callaway, D.Sc. Lond.—The Formation of Rock-Basins: J. D. Kendall, C.E.—On the Occurrence of a Remarkable and apparently New Mineral in the Rocks of Inverness-shire: W. Jolly, F.R.S.E., and J. M. Cameron. Communicated by Prof. J. W. Judd, F.R.S.—Further Discoveries in the Cresswell Caves: Prof. W. Boyd Dawkins, M.A., F.R.S., and the Rev. J. M. Mello, M.A., with Notes on the Mammalia by the former.—On the Probable Temperature of the Primordial Ocean of our Globe: R. Mallet, F.R.S.—On *Lepidodiscus Lebouri*, a New Species of *Agelacrinites* from the Carboniferous Series of Northumberland: W. Percy Sladen.
ROYAL MICROSCOPICAL SOCIETY, at 8.—New Method of Correcting Spherical Aberration: Prof. Abbe.—Prof. Abbe will also Exhibit his Apparatus for Demonstrating on a large Scale the Fundamental Experiment of the Theory of Microscopic Vision.—Note on Prof. Abbe's Apertometer: F. H. Wenham.—On the Theory of Illuminating Apparatus Employed with the Microscope: Dr. Fripp.

THURSDAY, JUNE 12.

ROYAL SOCIETY, at 4.
MATHEMATICAL SOCIETY, at 8.—Notes on (1) the Momental Plane; (2) a Property of Plane Curves; (3) a Prize Question of the Belgian Academy of Sciences: J. J. Walker.—Note on Determinants of n Dimensions: Lloyd Tanner.—Cases of Polygonal Inscription in a Circle: Rev. Dr. Freeth.
ROYAL INSTITUTION, at 3.—German Literature: Prof. Hillebrand.
ZOOLOGICAL SOCIETY, at 4.—Nocturnal Animals: Dr. Murie.

FRIDAY, JUNE 13.

ROYAL INSTITUTION, at 9.—The *Thunderer* Gun Explosion: F. J. Bramwell.
QUEKETT MICROSCOPICAL CLUB, at 8.

SATURDAY, JUNE 14.

PHYSICAL SOCIETY, at 3.—On the Suppression of the Induction Disturbance of the Telephone: Prof. H. McLeod.—On the Sensitive State of Electric Discharges through Rarefied Media: W. Spottiswoode and J. F. Moulton.—On a New Measuring Polariscope: Prof. W. G. Adams.
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GEOLOGISTS' ASSOCIATION.—Excursion to Sevenoaks and Tunbridge.

MONDAY, JUNE 16.

VICTORIA INSTITUTE, at 8.—Annual Address.

TUESDAY, JUNE 17.

ZOOLOGICAL SOCIETY, at 8.30.—On the Mollusca procured during the *Lightning* and *Porcupine* Expeditions, 1868–70. Part 2: J. Gwyn Jeffreys, F.R.S.—On the *Acanthomys leucopus* of Gray: Edward R. Alston, F.Z.S.—On the Manatee: Dr. J. Murie.

WEDNESDAY, JUNE 18.

METEOROLOGICAL SOCIETY, at 7.—Report on the International Meteorological Congress held at Rome, April, 1879: Robert H. Scott, F.R.S.—Thermometer Exposure—Wall *versus* Stevenson's Screens: William Marriott.—On the Hurricane at Mauritius on March 20–21, 1879: Charles Meldrum, F.R.S.—On a Remarkable Disturbance of Barometric Pressure observed at the Royal Observatory, Greenwich, on May 18, 1878: William Ellis, F.R.A.S.—Meteorology of Mozufferpore, Tirhoot, 1878: Charles N. Pearson.

CROYDON MICROSCOPICAL CLUB, at 8.30.

THURSDAY, JUNE 19

ROYAL SOCIETY, at 8.30.—On the Existence of Liebreich's Protagon in the Brain: A. Gamgee and E. Blankenhorn.—The Measurement of the Ratio of Lateral Contraction to Longitudinal Extension of a Body under Strain: A. Mallock.—The Determination of the Effects of Tidal Friction by a Graphical Method: G. H. Darwin.—An Account of Experiments on the Influence of Colloids upon Crystalline Form, and on Movements observed in Mixtures of Colloids with Crystalloids; and other Papers: Dr. W. M. Ord.

CHEMICAL SOCIETY, at 8.—On Gardenin: Dr. Stenhouse and Mr. Groves.—On the Action of Sulphuric Acid on the Hydrocarbons of the Formula $C_{10}H_{16}$: Drs. Armstrong and Gilden.—Researches on the Terpenes, Camphor, and Allied Compounds, Parts 1 and 2: Dr. Armstrong.—Contributions to the History of Starch and its Transformations: H. T. Brown.—On the Boiling Points of Certain Metals and Metallic Salts: Dr. Carnelly and W. C. Williams.—On the Determination of Nitric Acid by Means of Indigo: R. Warington.—On Dry Copper-Zinc Couples and Analogous Agents: Dr. Gladstone and Mr. Tribe.—Notes on the Purple of the Ancients: R. Schunck.

LINNEAN SOCIETY, at 8.—Carpesium as Indigenous to Australia: F. M. Bailey.—Flora of Northern China: J. G. Baker and S. Le Marchant Moore.—New Polyzoa: Prof. G. Busk.—Australian Lichens in R. Brown's Herbarium: Rev. J. M. Crombie.

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NATURE

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No. 503, Vol. 20] THURSDAY, JUNE 19, 1879 [Price Sixpence

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DIARY OF SOCIETIES.

LONDON

THURSDAY, JUNE 19.

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MONDAY, JUNE 23.

GEOGRAPHICAL SOCIETY, at 8.30.—Reports received from Mr. Keith Johnston, Commanding the East African Expedition:—(1) Excursion to the Usambara Hills; (2) Information obtained regarding Routes between Dar-es-Salaam and Lake Nyassa.

TUESDAY, JUNE 24.

ANTHROPOLOGICAL INSTITUTE, at 8.—On the Osteology of the Natives of the Andaman Islands: Prof. W. H. Flower, LL.D., F.R.S.—On Palæolithic Implements from the Valley of the Brent: Worthington G. Smith, F.L.S.—"Kemp How" Cowlam: J. R. Mortimer.—Portstewart and other Flint Factories of the North of Ireland: W. J. Knowles.—On some Eskimos Bone Implements from the East Coast of Greenland: W. J. Sollas, M.A., F.G.S.

METROPOLITAN SCIENTIFIC ASSOCIATION, at 7.—Annual Meeting.

WEST LONDON SCIENTIFIC ASSOCIATION, at 8.

HORTICULTURAL SOCIETY, at 1.—Scientific Committee.

WEDNESDAY, JUNE 25.

GEOLOGICAL SOCIETY, at 8.—The Formation of Rock-Basins: J. D. Kendall, C.E.—On *Lepidodiscus Lebouri*, a New Species of *Agelacrinites*, from the Carboniferous Series of Northumberland: W. Percy Sladen.—On Evidence that Certain Species of *Ichthyosaurus* were Viviparous: Prof. H. G. Seeley, F.L.S.—On *Dolichocephalus Prestwichi*, Seeley, an Ornithosaurian from the Stonesfield Slate of Kineton: Prof. H. G. Seeley.—On the Physical Geography of the North-East of England in Permian and Triassic Times: E. Wilson.—On the Diorites of the Warwickshire Coal-Field: S. Allport.—A Contribution to South-American Geology: George Attwood.—On the so-called Midford Sands: J. Buckman.—On the Ancient River-Deposit of the Amazon: C. B. Brown, Assoc. R.S.M.—The Glacial Deposits of Cromer: Clement Reid.—Notes on a Disturbance of the Chalk at Trowse, near Norwich.—The Submerged Forest of Barnstaple Bay: T. M. Hall.—On a Section of Boulder Clay and Gravels at Balleygalley Head, and an Inquiry as to the Proper Classification of the Irish Drift: T. Mellard Reade.—On the Augitic Rocks of the Canary Islands: Salvador Calderon. Communicated by the President.—On the Cambrian (Sedgw.) and Silurian Beds of the Dee Valley, as compared with those of the Lake-District: J. E. Marr.—On some Superficial Deposits in the Neighbourhood of Evesham: Rev. A. H. W. Ingram.

ROYAL SOCIETY OF LITERATURE, at 8.—On the Paris Literary Congress of 1878, and the International Literary Association: C. H. E. Carmichael.

FRIDAY, JUNE 27.

QUEKETT MICROSCOPICAL CLUB, at 8.

SATURDAY, JUNE 28.

PHYSICAL SOCIETY, at 3.

GEOLOGISTS' ASSOCIATION.—Excursion to Tunbridge and Tunbridge Wells.

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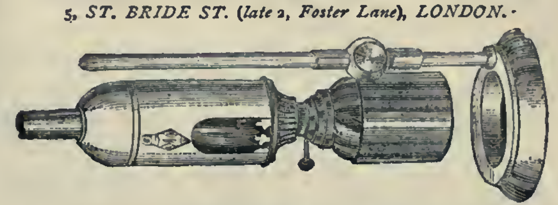

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FRIDAY, JUNE 27.

QUEKETT MICROSCOPICAL CLUB, at 8.

SATURDAY, JUNE 28.

PHYSICAL SOCIETY, at 3.
GEOLOGISTS' ASSOCIATION.—Excursion to Tunbridge and Tunbridge Wells.

MONDAY, JUNE 30.

STATISTICAL SOCIETY, at 4.30.—Annual Meeting.

WEDNESDAY, JULY 2.

ENTOMOLOGICAL SOCIETY, at 7.

THURSDAY, JULY 3.

GEOLOGISTS' ASSOCIATION, at 8.

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No. 505, Vol. 20] THURSDAY, JULY 3, 1879 [Price Sixpence

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DIARY OF SOCIETIES.

LONDON

THURSDAY, JULY 3.

GEOLOGISTS' ASSOCIATION, at 8.

MONDAY, JULY 7.

ROYAL INSTITUTION, at 5.—General Monthly Meeting.

TUESDAY, JULY 8.

WEST LONDON SCIENTIFIC ASSOCIATION, at 8.

FRIDAY, JULY 11.

QUEKETT MICROSCOPICAL CLUB, at 8.

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No. 507, Vol. 20] THURSDAY, JULY 17, 1879 [Price Sixpence

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DIARY OF SOCIETIES.

LONDON

TUESDAY, JULY 22.

WEST LONDON SCIENTIFIC ASSOCIATION, at 8.
HORTICULTURAL SOCIETY, at 1.—Scientific Committee.

FRIDAY, JULY 25.

QUEKETT MICROSCOPICAL CLUB, at 8.—Annual General Meeting.

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The candidate who may be selected for the above Professorship will have to enter upon his duties on the 1st November.

Dublin Castle, 5th September, 1879.

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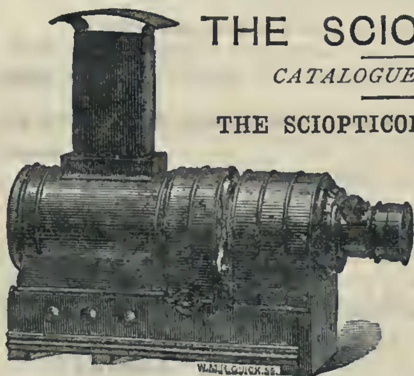

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SUNDAY, NOVEMBER 2.

SUNDAY LECTURE SOCIETY, at 4.—Science and Religion: Dr. Andrew Wilson.

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ROYAL INSTITUTION, at 5.—General Monthly Meeting.

WEDNESDAY, NOVEMBER 5.

GEOLOGICAL SOCIETY, at 8.—On the Probable Temperature of the Primordial Ocean of our Globe: R. Mallet, F.R.S.—On the Skull of *Argillornis longipennis*, Ow.: Prof. R. Owen, C.B., F.R.S.—On the Fish-remains found in the Cannel Coal in the Middle Coal-measures of the West Riding of Yorkshire, with the Description of some New Species: J. W. Davis.
ENTOMOLOGICAL SOCIETY, at 7.

THURSDAY, NOVEMBER 6.

LINNEAN SOCIETY, at 8.—On the Origin of the (so-called) Scorpoid Cyme: Rev. G. Henslow.—Instincts and Emotions in Fish: Dr. Francis Day.—On the Development of the Vegetable Embryo: H. M. Ward.
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FRIDAY, NOVEMBER 7.

GEOLOGISTS' ASSOCIATION, at 8.—Geology and its Uses: Prof. Rupert Jones.

SATURDAY, NOVEMBER 8.

PHYSICAL SOCIETY, at 3.—On an Analogy between the Conductivity for Heat and the Voltaic Induction-Balance Effect of Copper-Tin Alloys: W. Chandler Roberts, F.R.S.—On a Standard Cell: Capt. Armstrong, R.E.

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